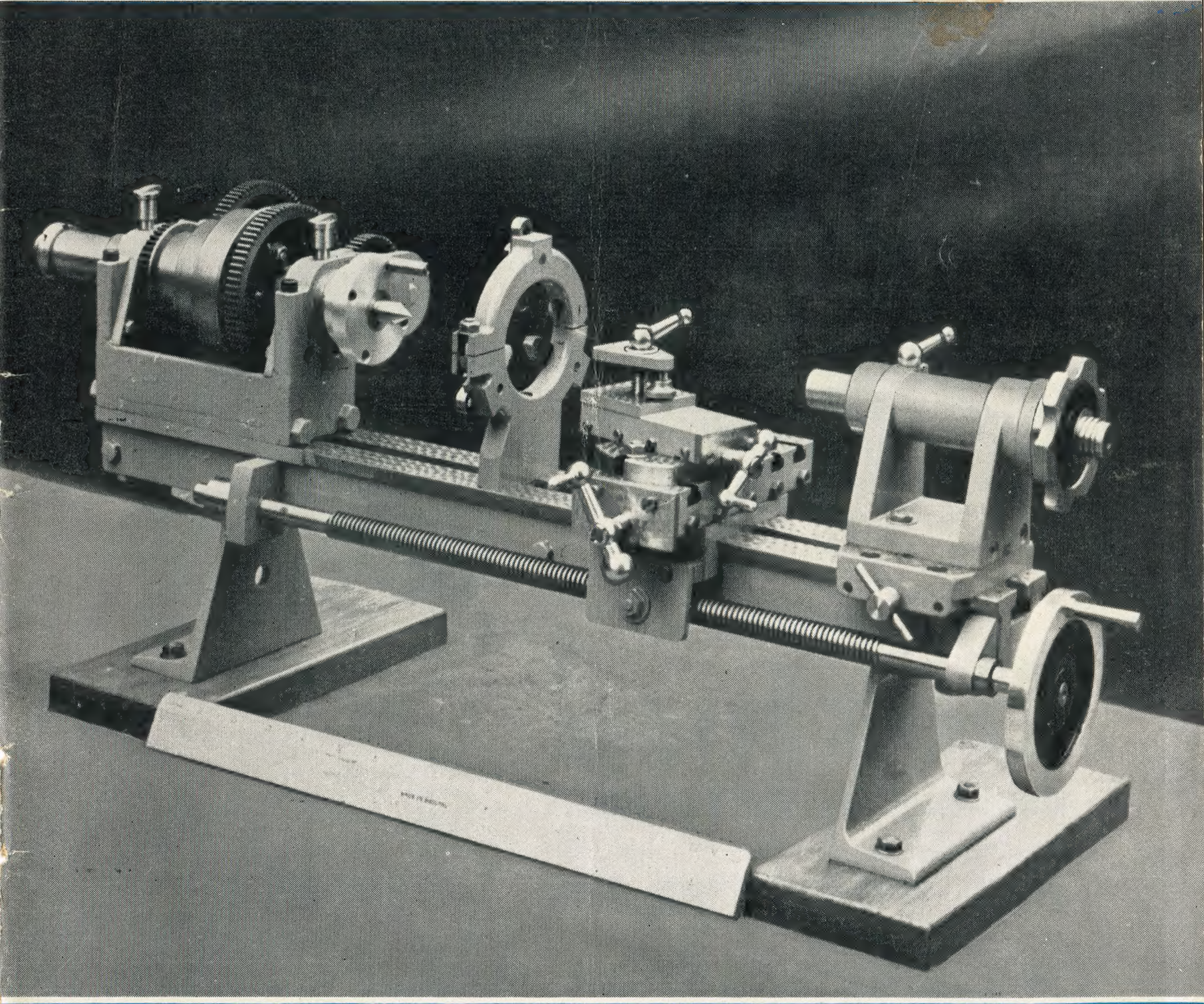
THE MODEL ENGINEER



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JULY 15th 1954
Vol. 111 No. 2773
9D

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is £2-2-0 post free

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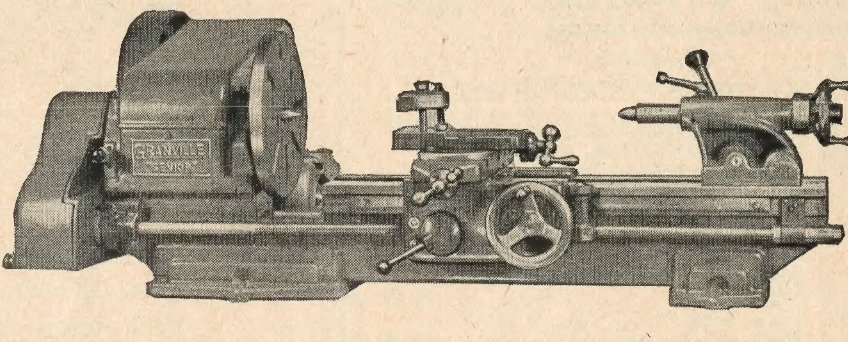

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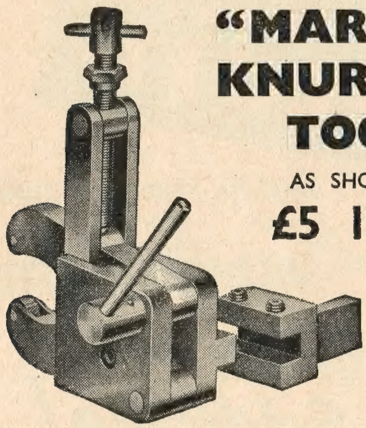

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THE MODEL ENGINEER

EVERY THURSDAY
Volume 111 - No. 2773
JULY 15th - 1954

ESTABLISHED 1898
PERCIVAL MARSHALL & CO. LTD. 19-20 NOEL STREET · LONDON · W.1.

CONTENTS

Our Cover Picture

The way in which model engineers can surmount the limitations of their equipment is well known to all our readers, and nearly every issue of this journal contains an account of some method or device whereby some difficult or hitherto impossible operation has been performed. Many model workshops are almost entirely equipped with home-made tools and machines, and these even include lathes of every type, from the crude or simple, to the precise or elaborate.

The lathe shown in this photograph was constructed by Mr. F. Few, of Hatfield, and is fabricated from mild-steel and cast-iron, the bed being of rolled steel sections; it is of 3½ in. centre height, and back geared, the gears being the only items not home made. All sliding ways have steel-to-cast-iron contact surfaces, and much of the machining of components has been done on the lathe itself while still incomplete, such as the line-boring of the tail-stock barrel, using a boring bar in the chuck, with the other end held in the three-point steady. Screw-cutting gear is not fitted at present, but will be added in due course.

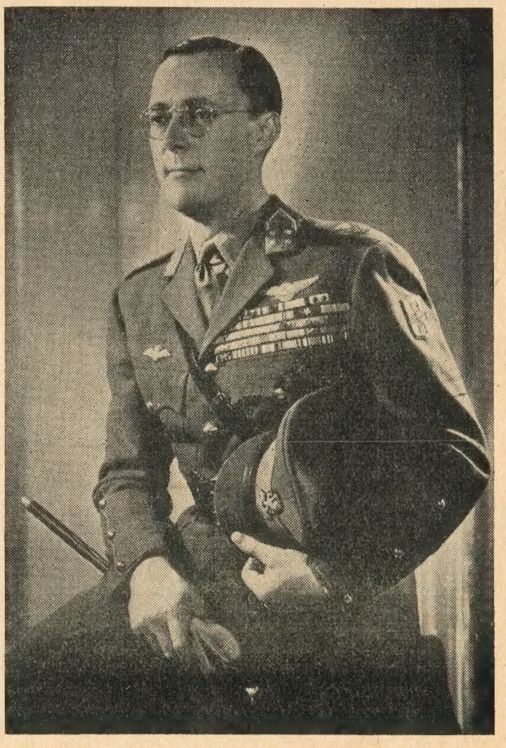
H.R.H. PRINCE BERNHARD TO OPEN THE EXHIBITION

WE are very glad to be able to announce that the "Model Engineer" Exhibition will be opened this year by H.R.H. Prince Bernhard of the Netherlands, who is not only well known and popular in Great Britain, but is also no stranger to the exhibition. His previous visits, however, have been incognito, and few people have been aware of his presence, though obviously he has a lasting impression of all that he has seen at our show.

The Prince is a keen sportsman, his main hobbies being flying and riding, in both of which he is expert; he is interested in mechanics and handicrafts, and, at the moment of writing, the indications are that there will be plenty for him to see and admire, once more, at the New Horticultural Hall.

The kindly interest of so distinguished a guest, as manifested by his ready response to our invitation, is indicative of his pleasurable recollections of the exhibition; moreover, it must surely be an inspiration and incentive to model engineers everywhere, and it will certainly lend an additional air of pride and pleasure to our show during its run from August 18th to 28th.

Every effort is being made to ensure that the 1954 "M.E." Exhibition shall be a memorable one in every section; a gratifying feature is the amount of new work that has been promised. Locomotives, ships power boats, cars, traction engines, aeroplanes workshop appliances and all the other things that fascinate model engineers, lose none of their appeal for young and old, in spite of the numerous counter-attractions that have come into existence in recent times. Nowhere is this plainer than at the "M.E." Exhibition, and the fact that our show may be counted, once more, as a Royal occasion, is a matter of the utmost satisfaction to everybody concerned.



Smoke Rings

Slough and Windsor Carnival

THE ANNUAL Slough and Windsor District Holiday Carnival at Agar's Plough, Windsor Road, Slough, will be held from July 31st until August 7th next. It will be open daily, except Sunday, from 2 p.m. till 10 p.m.

One of the features will be a model engineering exhibition organised by the Slough and District Model Engineering Society, in collaboration with neighbouring societies and model aero clubs, and the Slough Junior Technical School. The competition section of the exhibition will be open to all. The awards comprise no fewer than eleven challenge cups while, in addition, there will be three cash prizes in all classes of which there are five each for seniors of 18 years of age and over, and juniors under 18. Entry forms are obtainable from the Carnival Hon. General Secretary, W. J. Groome, Room 20, Town Hall, Slough, Bucks, and must be completed and returned by Saturday, July 17th.

Is It The Oldest ?

MR. W. J. HUGHES has written to say that Mr. John R. Hardy, of Ulleskelf, York, has recenty discovered, at Bishop Wilton, Yorks, an Aveling & Porter traction engine bearing the number 89 and built about 1884. It is an 8-h.p. single-cylinder engine which has been used for both haulage and threshing and is in *perfect* working order. It still has the original wooden front axle and is named, appropriately enough, *Endurance*.

This engine is about 70 years of age; its present owner is 72, and his father, the original purchaser of the engine, is still living, aged 94. Mr. Hardy wonders if there is an older engine in *good* working order, anywhere in the country. We doubt it, if we except the Aveling engine built 1871 and now in South Kensington Museum.

Two More Locomotives Preserved

TWO INTERESTING and historic locomotives have lately been added to the British Transport Commission's Museum collection. One is an all-but-forgotten L.N.W.R. 0-4-0 saddle-tank designed by John Ramsbottom and built at Crewe in 1865 as No. 1439. This engine did mostly dock shunting for the L.N.W.R. until 1914, and was rebuilt twice in the interim. In 1914, it was lent to the Kynoch Works, Witton, Birmingham, of the Imperial Chemical Industries Ltd., by whom it was eventually bought in 1919. In spite of the two rebuildings, the engine retains many features of old Crewe practice, such as: cast-iron wheels with I-section spokes; wooden brake blocks; an original Ramsbottom double-beat regulator and a " drop down " smokebox door with horizontal hinge. It has been repainted in the pre-1875 livery of green lined out in black and white.

The second engine referred to is one of the original Mersey Railway steam locomotives, No. 5, *Cecil Raikes*. This engine is one of nine specially designed and built by Beyer Peacock & Co. in 1885; they were extremely massive, double-framed 0-6-4 tank engines with inside cylinders, 21 in. dia. by 26 in. stroke, 4 ft. 7 in. coupled wheels, and were fitted with condensing gear. They had to haul heavily-laden trains through the Mersey Tunnel with its gradients of 1 in 27 at one end and 1 in 30 at the other. At the time of their construction, they were the most powerful steam locomotives in Britain. Since 1905, when the Mersey Railway was electrified, No. 5 has been used for heavy colliery work, but has now been withdrawn from service. She has been presented to the B.T.C. by the National Coal Board.

" The Saint " at Work

AT A garden party recently held in the old-world garden of the Vicarage at Bray, Berks, the Slough and District Model Engineering Society provided a portable track about 150 ft. long. The engine was Mr. P. F. Arnold's fine 3½-in. gauge G.W.R. 4-6-0, *The Saint*, which was illustrated and described in THE MODEL ENGINEER for March 25th last; she behaved in exemplary fashion and created considerable interest. From our own experience with her, we can say that she " handles " very well indeed; the regulator gives almost instantaneous control, as it should; the valve-gear can be notched-up nearly to mid-gear, immediately after starting in either direction, while the exhaust is clear, regular and snappy at all points of cut-off. The engine exhibits no idiosyncrasies for the unfamiliar driver to learn before he can get the best out of her. In short, she is truly Great Western in performance as well as in appearance.

Mr. Arnold tells an amusing little tale about her. Not being satisfied with the performance she was giving, he took her to pieces to see if he could discover what was wrong. He found that he had put the valves in sideways on in the buckles ! After turning them the right way about, he put the engine together again and got up steam; there has been nothing disappointing about the performance since. The moral of this is, of course, that some means should be provided to ensure that the valves fit into their buckles one way only.

Sir C. A. Parsons' Centenary

SIR CHARLES PARSONS was the greatest power engineer of his day and achieved an international reputation, for the steam turbine is used on every continent and has practically displaced the steam engine for generating power, both on land and sea.

His centenary is being commemorated at the Science Museum, South Kensington, by a special display in the East Hall. Sir Charles Parsons's original 7½ kW high-speed steam turbo-generator of 1884 is exhibited by the side of a scale-model, one-sixteenth full size, of a modern Parsons 50,000 kW steam turbo-alternator. As both exhibits occupy the same space, the vast development in power production over half a century is strikingly shown. Photographs show other important developments in mechanical, electrical and marine engineering and in the optical industry, due to his pioneer researches and inventions.

The attention of visitors is also drawn to numerous other examples of the work of Sir Charles Parsons, exhibited in various galleries of the Museum. He died on February 11th, 1931, in Jamaica, whilst on a cruise, in his 77th year.

Hours of opening: Weekdays, 10 a.m. to 6 p.m.; Sundays, 2.30 to 6 p.m. Admission free.

Guinea-Pig Models

BRIDGE-BUILDING IN MINIATURE FOR RESEARCH AT THE N.P.L.

By J. Dewar McLintock

SOMEWHERE behind the rather forbidding walled perimeter of the National Physical Laboratory, a man works quietly and painstakingly in a corner of a spacious woodwork shop. Near him another man is turning a large wooden pattern on an outsized woodworker's lathe, whilst others are at various tasks, using robust timbers. This man, however, is carefully drilling a seemingly endless series of tiny holes in a slim slip of wood, ready to receive many short lengths of wire.

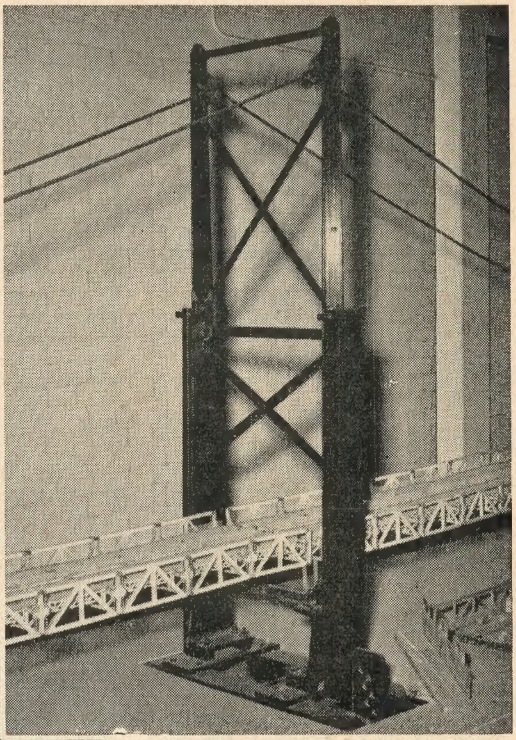
The structure takes on the appearance of some form of railing, in miniature, and this pleasant mystery is resolved when he moves to another bench, where there is part of an admirable wooden model of a suspension bridge, nearing completion.

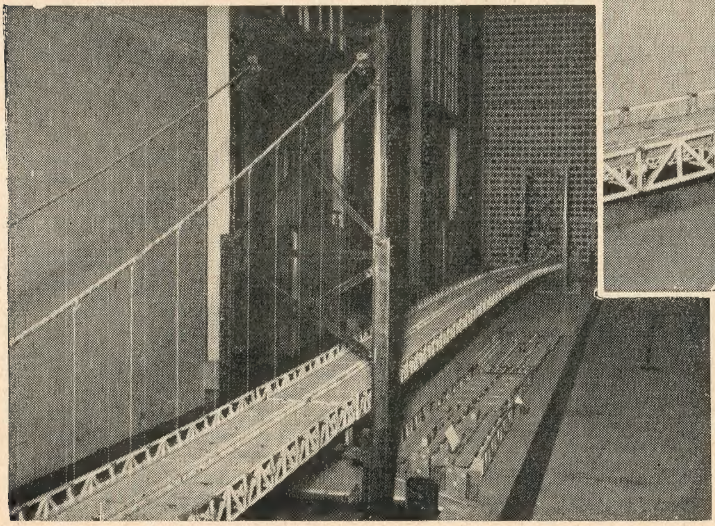
There is no question as to whether he is working correctly from the the original or not. It might, in fact, be said that this *is* the original, for it is the first three-dimensional result of the bridge designer's conception. Moreover, it is going to play a most vital part in the whole scheme of building the full-scale bridge, because only with the aid of this beautiful but delicate miniature will it be possible to determine whether the design is safe . . . or deadly dangerous.

This kind of model-making is almost a continual process at the laboratory. Models are made for many purposes, and it would be impossible to cover the entire field in a single article. That model was still under construction, at the time of writing, but it is of interest to consider some earlier work in the same field, and it will be seen that whilst such models are but the means to an end, they represent indispensable links in the entire chain of research Readers will have heard of the proposed Severn Bridge. It is, indeed, an evergreen topic, for in all probability the bridge will be constructed in the reasonably near future, and it is certainly something that is needed urgently.

In 1946, the National Physical Laboratory (Aerodynamics Division) started work of an experimental nature, on behalf of the Ministry of Transport, to "give guidance on the aerodynamic design aspects" of the proposed bridge. This meant that the laboratory was charged with the duty of assessing the safety or otherwise of the original design in respect of wind-effects, and the experiments went on until 1951, by which time many design-modifications had been made and the stability of the final design was confirmed. During that time, the model-makers had been busy and without their efforts, it would have been economically impossible to arrive at the desired conclusions.

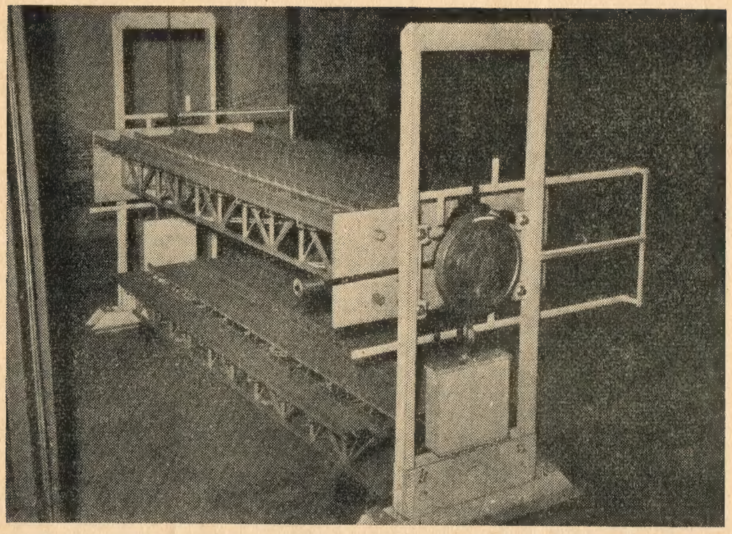
The authorities directly responsible for this work were Dr. R. A. Frazer, F.R.S., and Mr. C. Scruton, B.Sc., A.F.R.Ae.S. Mr. Scruton has noted, in one of his erudite works on the subject, that failures of suspension bridges have resulted from oscillations set up by steady winds. In 1836, one span of the old Chain





The actual suspension arches of the bridge were not built to scale, because they do not affect the aerodynamic characteristics

Left: The complete model had been set in oscillatory motion when this photograph was taken. Hence the "twist" seen



Different types of sectional models were tested, to confirm results

Pier at Brighton was broken by torsional oscillation. Then there was the spectacular failure of the original Tacoma Narrows suspension bridge in America some years ago. It was destroyed within an hour by oscillations which started quite without warning in a 42 m.p.h. wind.

It was this alarming evidence of the remarkable destructive power of such oscillations that caused authorities here and in America to experiment with small-scale models in wind tunnels, and the results obtained by the method appeared to be excellent. At any rate, the second Tacoma bridge still behaves itself in high winds !

It is very interesting to note that in the early stages of Frazer's and Scruton's work, a scale model of the entire bridge was made. They were almost certain that models of spans or sections of bridge would adequately serve their purpose in wind tunnels, but it was characteristic of the National Physical Laboratory that the first approach should be to make *certain* that such was the case. When this was established, models of comparatively short lengths of bridge were indeed used, for proving and development work. From our point of view, however, the full model is the most interesting, and will be given prior consideration.

It should be appreciated that this was model-making " with a difference." It is one thing to make a model which is, in all dimensions, a faithful replica of the prototype-design, but quite another to make a model in which such properties as elastic and inertial properties, structural damping, etc., are reproduced at least with reasonable similarity.

The 1/100-scale full model represented a truss-stiffened bridge of width 107 ft. with a 3,000 ft. centre-span and two equal 1020 ft. side-spans. The required stiffness and inertial properties of the suspended structure were obtained by the use of light rigid components interconnected by steel springs. These rigid components were mostly of aluminium-balsa wood sandwich construction, and each spanned the equivalent of 60 ft. between adjacent cross-girders. The roadways were not continuous in each span, but were divided into segments separated from one another by small gaps at the cross-girders. The supports for these segments consisted of thin vertical steel blades fixed centrally to the two end cross-girders concerned, with their planes at right angles to the span.

Both the elastic and inertial properties of the towers were variable but it was not considered necessary to reproduce the correct external shape of either the towers or the anchorages. The model cable consisted of piano wire of diameter 0.024 in. which provided the equivalent of full-scale cross-sectional area of about 450 sq. in. with a 1/100 reduction of Young's modulus. To obtain the correct mass and external shape, hollow brass cylinders were spaced along the wire, and fixed by grub screws.

The model suspenders were made of fishing line which had been pre-stretched and treated with a beeswax coating to reduce the effect of humidity changes on its length. The tiny handrails were made up in sections on jigs, and for the many hundreds of vertical supports the model-makers used carpet thread dipped in acetate. The complex girders known as stringers and used to support the roadway, as well as strengthen the general structure, were also jig-built, the materials in this case being acetate sheeting and wood. Only by the use of such materials, and by means of artificial flexing devices, could anything resembling the true mass-elasticity ratios be retained.

The following full-model prototype scales may be of interest: Lengths $\frac{1}{100}$ Weights $\frac{1}{1,000,000}$ Stiffness(moment/radian) $\frac{1}{100,000,000}$ Frequencies, ten times; Wind speed one tenth. Some direct comparisons are as follows: Main span, 3,000 ft. (30 ft.); total span 5,040 ft. (50.4 ft.); wind speed, 136 m.p.h. (20 ft. per sec.).

This model was mounted in a wind tunnel of the non-return flow type, and using only one fan. It was erected in a disused aircraft hangar and the fabric of the tunnel itself was mainly of timber, lined with wallboard. It is characteristic of the thorough methods of the " N.P.L." that the aerodynamic qualities of the tunnel were first tested with a 1/12 scale model of the complete tunnel and the hangar in which it was to be housed.

The model was mounted on a horizontal turntable. Changes of the horizontal wind direction were reproduced by rotation of the turntable and the effect of vertically inclined winds was simulated by tilting the whole model about a span-wise axis near the wind-tunnel floor. In the latter case, representation of gravitational forces was restored by attaching long cords and weak springs.

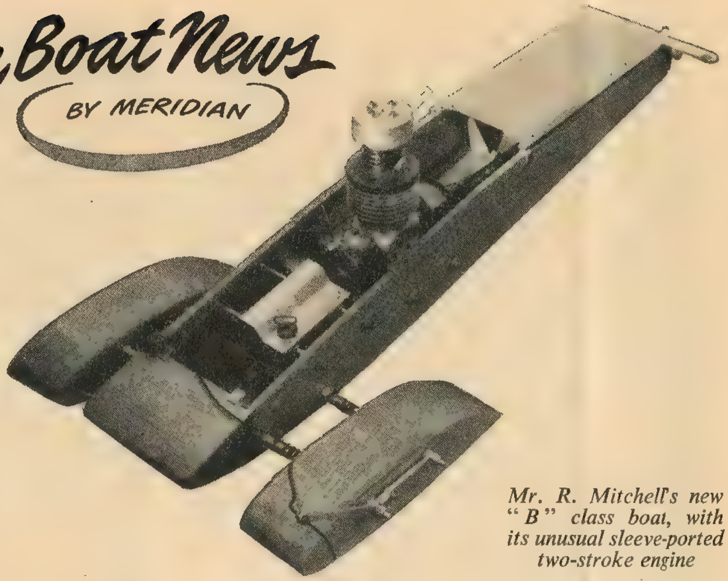
Tests were made to determine the influence of numerous design-variations such as grade-line camber, tower-stiffness, cable loading and the effects of modifications to the external shape of the suspended structure. By covering the stiffening-truss panels with paper, it was possible to simulate the aerodynamic effects of a plate-girder-stiffened bridge, and this type of structure exhibited a high degree of instability.

Experiments were meanwhile being carried out with models of 340 ft. lengths of the bridge, also on the 1/100 scale. These were of rigid wooden construction and were

(*Continued on page* 63)

Model Power Boat News

BY MERIDIAN



Mr. R. Mitchell's new "B" class boat, with its unusual sleeve-ported two-stroke engine

THE FOREST GATE AND BOURNVILLE REGATTAS

A REGATTA was held on a recent Sunday by the Forest Gate M.P.B.C., and was the first ever to be held by this club.

Although there is a lake available on Wanstead Flats, Victoria Park was chosen as the venue, owing to various difficulties connected with the home water.

This change enabled the programme to be widened to include speed events as well as the straight events already planned, and the regatta proved to be interesting and successful.

Highlights in the straight events included a tie in the Steering Competition between G. Jones (Victoria), and J. Chandler (Southend) which resulted finally in a victory for the former competitor. There was also a tie for third place, and the standard of steering was quite high with good scores.

The speed events also provided some thrills, particularly when in the Class "A" race Mr. J. Innocent's *Betty* flipped at over 60 m.p.h. Although a double loop was achieved in this spectacular capsize, only minor damage was sustained, and a second run was completed successfully, this time at lower speed. It should be mentioned that *Betty* is 21 years old this year, and the hull is now decorated with a little silver key !

The Forest Gate club has been affiliated to the M.P.B.A. only a comparatively short time, and its members are to be congratulated on a very successful first regatta.

Results:

Nomination Race

(1) E. Vanner (Victoria), *Leda III*: 0.9 per cent. error.

(2) S. Dearling (Blackheath), *Maj*: 1.3 per cent. error.

(3) A. Falconer (Blackheath), *Golden Maria*: 1.5 per cent. error.

Steering Competition

(1) G. Jones (Victoria), *Fidelis*: 13 + 3 points.

(2) J. Chandler (Southend), *Iope*: 13 + 1 points.

(3) J. Innocent (Victoria), *Betsy*: 11 points.

500 *yd.* "*C*" *Restricted Race*

(1) W. Everitt (Victoria), *Nan*: 56.35 m.p.h.

(2) K. Hyder (St. Albans), *Slipper* 4: 55.74 m.p.h.

500 *yd. Class* "*C*" *Race*

(1) E. Woodley (Victoria), *Christine II*: 40.42 m.p.h.

500 *yd. Class* "*B*" *Race*

(1) S. Poyser (Victoria), *Rumpus* 7: 46.07 m.p.h.

(2) G. Lines (Orpington), *Genevieve*: 45.4 m.p.h.

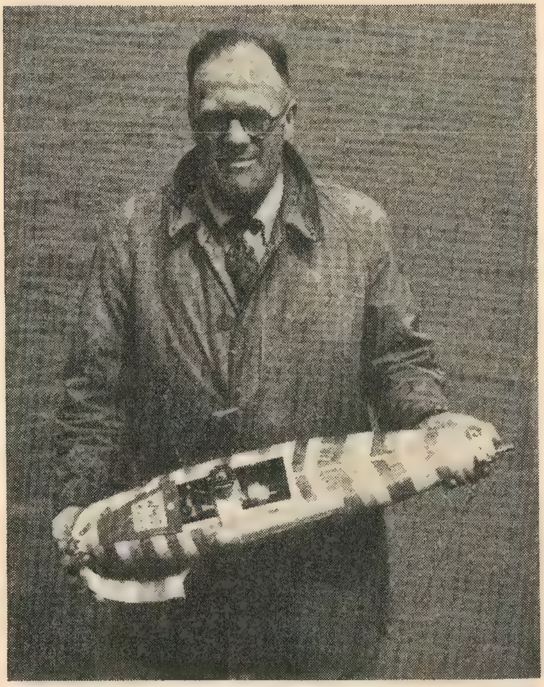
500 *yd. Class* "*A*" *Race*

(1) N. Hodges (Orpington), *Rita II*: 51.39 m.p.h.

(2) J. Innocent (Victoria), *Betty*: 50.32 m.p.h.

Mr. M. Halligan (Wallasey) with his steam launch "Margaret"

Veterans both—Mr. G. D. Noble (Bristol) and "Bulrush 9"



Mr. H. Stanworth (Bournville) introduces a new colour scheme in his new "C" class boat

The Bournville Regatta

The annual Whitsuntide regatta of the Bournville club again attracted a good entry, particularly from the Northern clubs; Altrincham, Maghull and Wallasey, for example, were well represented, and from the West came a team which included one of the pioneers of model power boats, Mr. G. D. Noble, of Bristol, who entered two boats in the speed events.

Among the interesting craft present was a new two-stroke "B" class boat by R. Mitchell, of Runcorn. This engine is of unusual design; the exhaust being discharged from the head *via* a ported sleeve. The effective piston area is thus ring-shaped, as opposed to the disc presented by a normal piston.

The programme opened with a steering competition for the A. Hackett Trophy, but the course proved to be a difficult one—in fact, one only had to score at all in order to get a place! The winner was Mr. Halligan (Wallasey) after a tie with Mr. Kirkham (Swindon).

In the speed events, the smaller hydroplanes were not at all happy in the water. There were many capsizes—mainly due to a swell on the surface, rather than really rough water.

The wonderful reliability of Mr. Mitchell's boats showed the way in the Class "C" and Class "B" races—first place in the latter and first and second in the former event.

Highest speeds were provided by the Class "A" boats, but the race ended in a tie between W. Brightwell (Wicksteed) and J. Benson (Blackheath). Both competitors recorded 58.4 m.p.h. with their respective boats. Unfortunately, Mr. Brightwell had transmission trouble, and could not re-run, and Mr. Benson's boat flipped while trying to better the speed.

Results

Steering Contest for A. Hackett Trophy

(1) M. Halligan (Wallasey), *Margaret*: 3 points + 1.

(2) Mr. Kirkham (Swindon), *Kenmore*: 3 points + 0.

(3) Mr. Skingley (Victoria), *Josephine*: 1 point.

(Possible score—9)

500 *yd. Race for "C" Restricted Hydroplanes*

(1) K. Hyder (St. Albans), *Slipper* 4: 48.7 m.p.h.

(2) S. Poyser (Victoria), *Rumpus* 7: 39.6 m.p.h.

(3) W. Morris (Bournville), *Hank*: 37.5 m.p.h.

500 *yd. Race for Butson Trophy (Class "C")*

(1) R. Mitchell (Runcorn), *Gamma III*: 42.6 m.p.h.

(2) R. Mitchell (Runcorn), *Gamma II*: 40.7 m.p.h.

(3) D. Innes (Altrincham), *Jo-Mac*: 38.3 m.p.h.

500 *yd. Race for Collier Trophy (Class "B")*

(1) R. Mitchell (Runcorn), *Beta* 4: 44.4 m.p.h.

(2) S. Poyser (Victoria), *Rumpus* 8: 39.0 m.p.h.

(3) A. Cockman (Victoria), *Ifit* 9: 36.3 m.p.h.

500 *yd. Race for Coronation Trophy (Class "A")*

(1) W. Brightwell (Wicksteed), *W*14: 58.4 m.p.h. and J. Benson (Blackheath), *Orthon* 58.4 m.p.h.

(3) W. Everitt (Victoria): 47.8 m.p.h.

THE WELLING REGATTA

Reported by J. G. Slender

THIS regatta was held recently in Belvedere Recreation Ground, Kent, the lake of which is set in a natural amphitheatre, and provided an ideal setting, marred only by the fact that the water is rather shallow and there is a fountain in the centre of the lake.

The events were for free-running and radio controlled boats only, and was supported by members from the following clubs: Victoria, South London, Kingsmere, Southend, Blackheath, Bromley and the home club Welling, making a total of 26 entries.

The first event was a nomination race of approximately 40 yards, the results of which were as follows:

(1) H. A. Perkins (Victoria) *Lilian*: 0.88 per cent. error.

(2) J. G. Slender (Welling), *Sarah Ann*: 3.7 per cent. error.

(3) B. Cleary (Blackheath), *Patricia*: 4.35 per cent. error.

The steering event followed, and although the course was only about 40 yds. long, the shallow water caused many of the boats to play tricks; the scoring was, therefore, not very high. Two boats tied for 1st place, with a score of 9 points each, and after a re-run, the result was as follows:

(1) F. Holme (Blackheath), *Doris*: 9 + 3 points.

(2) G. Caird (Bromley), *BOAC* 51: 9 + 0 points.

(3) S. Dearling (Blackheath), *Maj*: 7 points.

The next event was the club Nomination Race, in which a team of three boats from each club took part, each boat being required to run up and down the 40 yd. course once, and the total time for the three boats was nominated by the team. This was supported by a total of seven teams, and resulted in a win by the Kingsmere team.

(1) Kingsmere (Messrs. Curtis, Morgan, Vanner): 7.05 per cent. error.

(2) South London (Messrs. Bittle, Caird, Cassenet): 7.47 per cent. error.

An interval followed for tea, during which competitors for the Radio Control event tuned up and adjusted their sets. Each competitor was allowed five minutes to burst as many balloons as he could or pick up the floating dolls, a point being allowed for every balloon or doll. The results were as follows:

Radio Control

(1) G. Caird (Bromley), *BOAC* 51: 6 points.

(2) I. R. Bittle (S. London): 5 points.

Whilst these events were being run on the pond, the club's model locomotive track was in operation, giving free rides to the children, and it was in great demand, having carried approx. 1,300 children during the afternoon's running.

The prizes were presented to the winners by His Worship the Mayor of Erith, accompanied by the Mayoress, who were introduced by Mr. C. Clarke the Welling Club's chairman, and from his speech and remarks to each competitor it was obvious that the mayor was interested and had a very enjoyable afternoon watching the regatta.

GUINEA-PIG MODELS

(*Continued from page* 60)

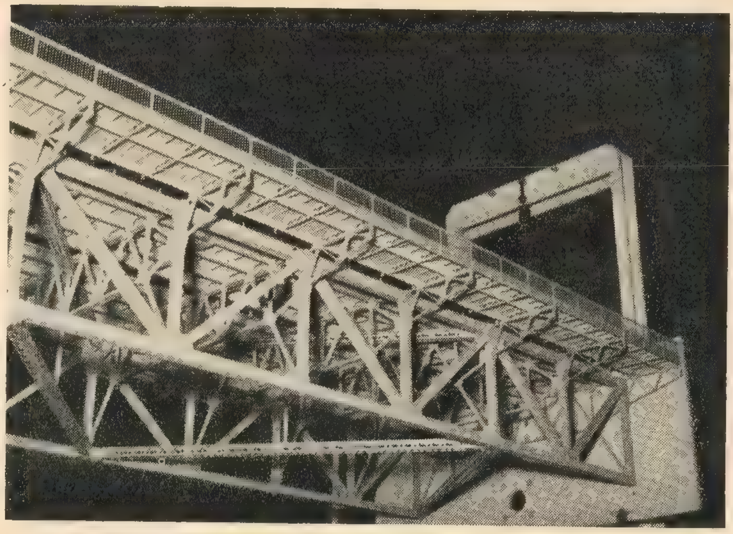
mounted on quite elaborate spring-loaded frames, with carefully calibrated stiffening and damping arrangements so that characteristics of the full suspended structure could be represented.

All result showed very good agreement between the two methods of test, and supported the conclusion that reliable predictions could be based on sectional model tests only.

It is perhaps worth while to "recap" at this stage. What had happened was that a first-class model of a suspension bridge, with elasticity, mass, etc., closely represented, had been tested as to the effects of "scale-size" winds. Meanwhile, *rigid* but geometrically-correct 1/100 scale *sections* were being tested in wind tunnels and given the required elasticity, etc., by artificial means, i.e. springs, hydraulic dampers, etc.

Several different designs were tested with the 1/100 scale sections and finally the team arrived at a design having stability characteristics superior to those of all the others, and which increased the estimated critical speed for torsional oscillations of the full-scale bridge to over 250 m.p.h.

Construction of a new full model representing the preferred design was now considered to be unnecessary, but to provide a confirmation of the stability, tests were made with a 1/32-scale sectional model. This increase of the linear scale allowed a more accurate representation of fine structural detail, and the satisfactory results set the seal on this remarkable and unheralded work of the Aerodynamics Division of the National Physical Laboratory.



The underside of this 1/32-*scale model shows a wealth of detail*

L.B.S.C.'s *Netta*

OUTSIDE ACCESSORIES

OH dear! *What* a job it is, to bring up a family of quins! It is involving much more work than I anticipated, but Curly never shied at "hard labour" yet, and doesn't shirk it now, so let's get on with it. The trouble in arranging for a satisfactory layout of the guide-bar-and bracket assembly, is the fact that clearance has to be provided for the coupling-rods, the swing of which, in the smaller sizes, leaves no room for direct attachment of the brackets to the frame. After drawing out and discarding three previous schemes, I adopted the one shown, which gets over the trouble fairly easily. This arrangement of turning spigots on the ends of the bars, to fit holes in the brackets, is the same as used on my *Jeanie Deans*, and has proved quite satisfactory; and the running-board (known among full-size enginemen as the "gangway") is quite strong enough to support the brackets, on the gauge "O" and gauge "1" locomotives.

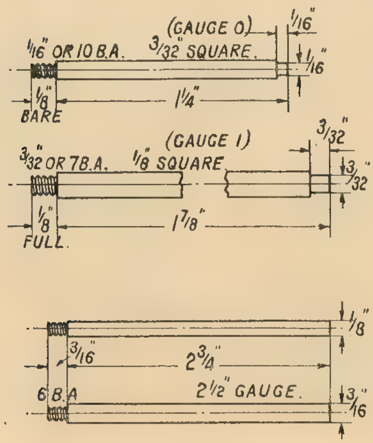
In these two sizes, the bars are just pieces of square silver-steel, of the sizes given in the illustrations. Cut the pieces to full length—four are required—chuck truly in the four-jaw, face the ends, and turn down and screw as shown. Then reverse each in the chuck, and turn the little spigots on the other end. As these should be a good push fit in the holes in the brackets, drill a No. 52 or No. 41 hole in a bit of scrap sheet metal, and use it as a gauge.

The bars for the 2½-in. gauge quin are made from ⅛ in. × 3/16 in. steel, either mild or silver-steel will do. They are chucked, and the attachment end turned and screwed, in a similar manner to the weenier bars; but no spigot is needed, as the outer ends of the bars are secured to the brackets by screws. As both ends of the bars on the 3½-in. and 5-in. gauge engines are also screw-attached, they only need squaring off to length, and drilling as shown.

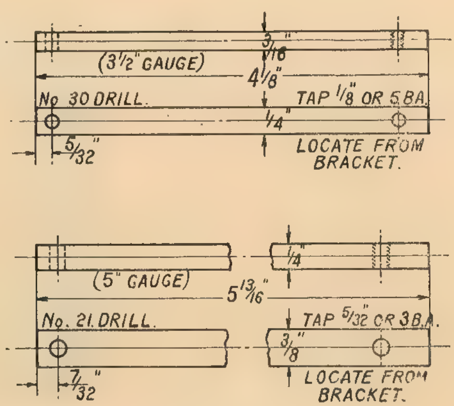
Crossheads

The crossheads should be made before the brackets are fitted, so that when erecting, you can make certain that the crossheads slide easily up and down, between the bars. To ensure clearance for the leading boss on the coupling-rod, that side of the crosshead, which is nearest the frame, needs a very thin flange, with nothing projecting from the side. This means cutting it pretty fine on the smaller quins; and to get over the trouble, I am specifying a crosshead with a pin-drilled recess for the little end of the connecting-rod, for gauges "O" and "1." The head of the pin is enlarged to fit the recess; and a plate, cut to the proper shape, is attached to the outside, and provides additional support for the pin, besides adding to the appearance.

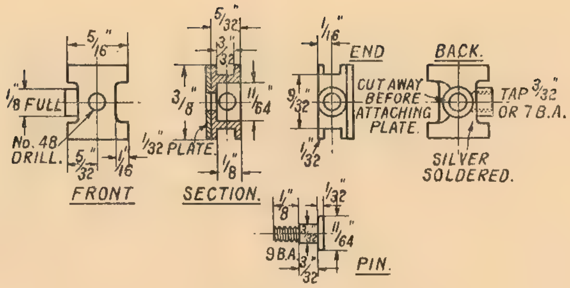
The construction is the same for both sizes. Either brass or steel can be used as desired; for gauge "O" it should be 5/32 in. × ⅜ in. section, and for gauge "1," ½ in. × 3/16 in. Saw or part off a piece long enough for two crossheads, with allowance for cutting them apart. Mill the top and bottom grooves, either by holding in a machine-vice on the lathe saddle and running under a regular end-and-face cutter on an arbor between centres, or else clamping on their side under the slide-rest tool-holder, and forming the groove with an end-mill in the three-jaw, like axleboxes. If the piece of metal has been sawn, square off the ends in the chuck, and mark off, from each end, the position of the holes for the crosshead pins; drill No. 48 or 30, according to gauge of engine, and pin-drill out the recesses as shown. I have



Guide bars (smaller gauges)



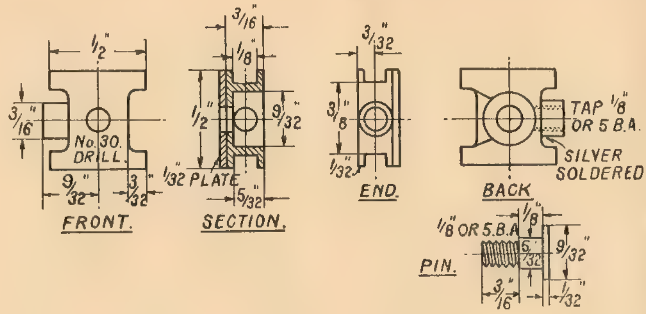
Guide bars (larger gauges)



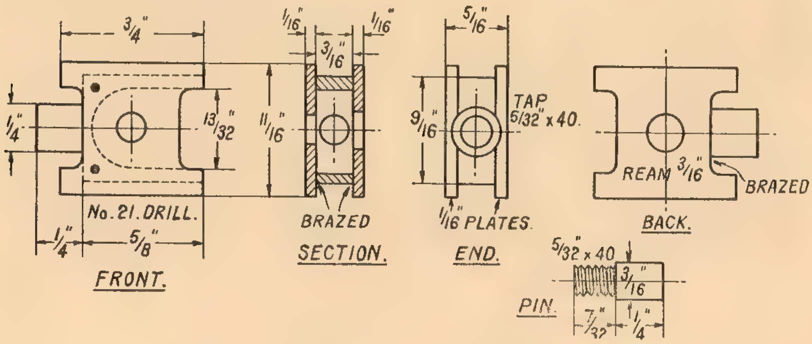
Gauge "O" crosshead

described how to make pin-drills umpteen times already, so needn't waste space going over it again here. Saw the piece in half, and square off the ends to dead length; or part in the lathe if you prefer it. The centre part of each crosshead can then be filed to the shape shown, leaving one end flat, to carry the boss, and filing away the other end until you cut right into the pin-drilled recess, sufficiently to allow the little end of the connecting-rod to swing a little, when the boss of same is in the recess. This is shown in the back views of the crossheads.

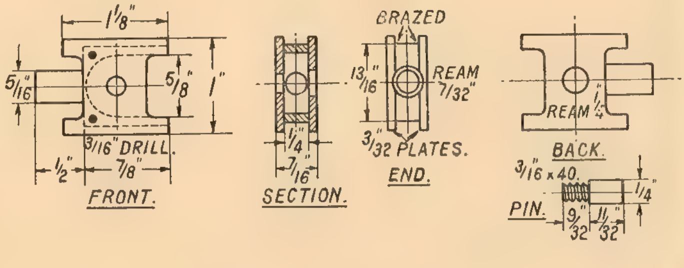
The sideplate on both sizes of crosshead, is made from 1/32 in. or 22-gauge sheet metal, filed to the shape shown; but it is a good wheeze to leave it a little oversize at first. Now be careful over this bit, as the process isn't shown on the drawings. Right in the middle of the end which will carry the boss, mark off and drill a little hole, say $\frac{1}{16}$ in. or thereabouts. Chuck a piece of $\frac{1}{4}$-in. or $\frac{3}{16}$-in. rod, according to size of engine, and turn a pip on the end, about $\frac{1}{16}$ in. long, to fit tightly in the hole; part off enough to form the boss. Press the spigot or pip into the hole in the end of the crosshead. Lay the plate in your brazing pan, smear some wet flux over it, and carefully set the crosshead on it, pin-drilled side up. Heat up slowly to dull red, taking care to avoid shifting the crosshead on the plate, and apply a weeny bit of best-grade silver-solder to joint between cross-head and plate, and where the boss touches the crosshead. Use the Cohen-McPherson technique, to avoid filling up the grooves, or ye'll hae tae mill them oot again and that vos sheer vaste; vot you tink, eh? If the crossheads are brass, quench in acid pickle; if steel, use water only. File any of the plate that might project, flush with the crosshead, and drill the pinhole through the plate using the hole at the bottom of the recess for a guide. Finally, chuck the cross-head truly in the four-jaw, boss outwards, face the boss, centre and drill and tap to suit the piston-rod. Clean up all over, if necessary, then turn the pin from a bit of round rod held in the three-jaw. Turn down and screw first, to given size and length, then turn the part which will go through the little end, finally turning the head to a push-fit in the recess; and parting off at a



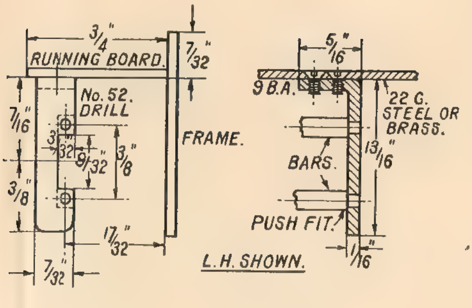
Gauge "1" crosshead



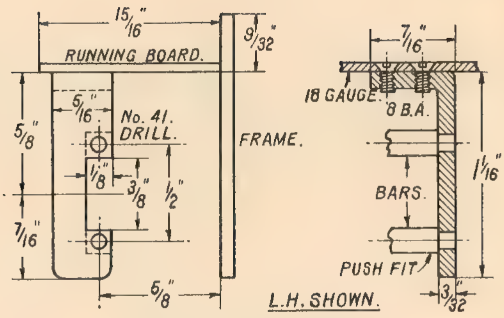
Crosshead for $2\frac{1}{2}$ in. gauge engine



Crosshead for $3\frac{1}{2}$ in. gauge engine



Guide bar bracket (gauge "O")



Guide bar bracket (gauge "I")

full 1/32 in. from the shoulder. Reverse in chuck, and skim off truly to dead length.

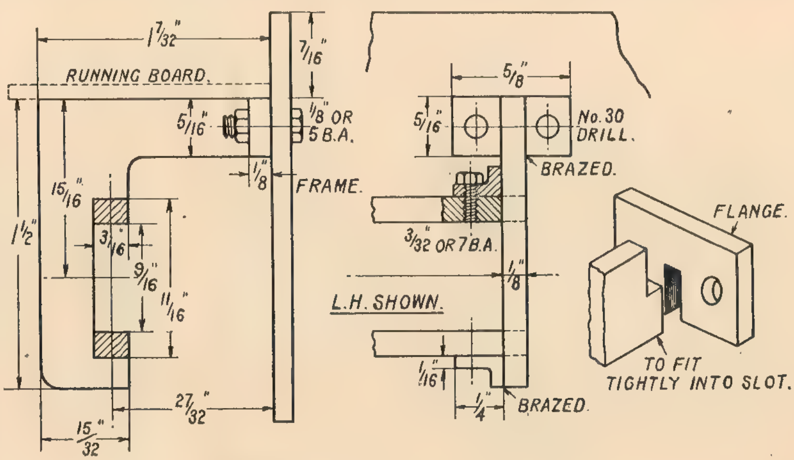
Crossheads for 2½-in. and 3½-in. Gauge Engines

These are made in a different manner to those previously described, as we have a little more room to play about in. Each crosshead is just a small piece of rectangular bar, slotted out to form a jaw, with a plate at each side of it, and a boss at the end. Here is an easy way to form the jaws: Take a short length of bar, long enough for the two crossheads. For the 2½-in. gauge engine, this should be $\frac{3}{16}$ in. × $\frac{9}{16}$ in. section, and for the 3½-in. job, ¼ in. × $\frac{13}{16}$ in. I recommend steel for this size, but a bit of good hard bronze would be quite O.K. Square off the ends; then, on the centre-line, at ⅜ in. from the end, in the smaller size, and $\frac{9}{16}$ in. in the larger, drill a ⅛-in. pilot hole, opening out to 13/32 in. and ⅝ in. respectively. Carefully saw down from the end of the piece of bar, to meet the holes, trim with a file, and there are your jaws. Chuck the piece of bar truly in the four-jaw and part off the jawed end, to a length of ⅝ in. for the 2½-in engine, and ⅞ in. for the 3½-in. job. Turn end for end, ditto repeato, and you should have two perfect crosshead centres.

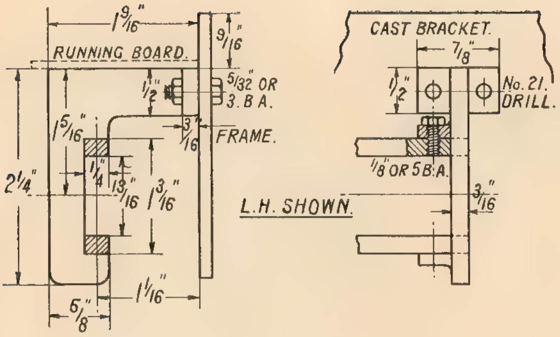
The side plates are cut from sheet metal, 16 or 13 gauge, according to size of engine, and the dimensions are given in the illustrations. They are brazed, or silver-soldered, to the centre piece; but to avoid any chance of shifting during the operation, it would be advisable to put a couple of rivets through the lot. Temporarily clamp the plates together, with the jaws between them, drill a couple of holes with No. 52 drill at the points indicated by dots in the illustration, and use either $\frac{1}{16}$-in. rivets, or bits of 16-gauge copper wire. No fancy heads needed, just bash over any-old-how; they are filed off after the brazing job is done. The great thing is to hold the lot rigid pro tem. Next, turn and fit the bosses by the method described for the smaller crossheads, drilling 3/32-in. holes in the centres of the ends and turning the pips to fit.

Smear some wet flux along the top and bottom grooves, and around the bosses; lay the crossheads in the brazing pan, heat to bright red, and touch the joints with a bit of soft brass wire, about 16-gauge, or a $\frac{1}{16}$-in. Sifbronze rod. For bronze crossheads, use best-grade silver-solder, or Easyflo. The warning about not blocking up the grooves, applies equally here; also, don't let any brazing material get into the jaws, as it is more difficult to clean out. Clean brazing, or silver-soldering, only requires the average amount of gumption which I am sure all followers of these notes possess; they just have to use it—and Bob is their uncle! Quench out, clean up, and file off the temporary rivet heads, also trim the edges if needed. Chuck truly in the four-jaw, boss outwards; face boss, centre, and for the 2½-in. gauge engine, drill No. 30, and tap 5/32 in. × 40. For the 3½-in. gauge quin, drill No. 5 and ream 7/32 in. Carefully mark off the centre of one of the side plates; on the 2½-in. gauge crosshead, drill right through both plates with No. 21 drill, using either drilling-machine or lathe, as the holes must go through dead square with the sides. Open out one side only, with No. 13 drill, and ream $\frac{3}{16}$ in. On the larger crosshead, drill through $\frac{3}{16}$ in. and open out and ream one side to ¼ in. The pins are just bits of $\frac{3}{16}$-in. or ¼-in. round steel, turned down and screwed as shown, no heads being needed.

All being well, the crossheads for the 5-in. gauge quin will be illustrated and described separately, along with the guide bar brackets, and I hope to include a drawing of the whole bag of tricks assembled, which will include connecting-rod and other details applicable to the whole



Guide bar bracket (2½ in. gauge engine)



Guide-bar bracket ($3\frac{1}{2}$ *in. gauge engine*)

family. This should appear in the next instalment.

Guide-bar Brackets

In the smaller sizes, the guide-bar brackets are built-up; in the larger sizes, they can be cast or built-up as desired, but the castings will save work. In gauges "O" and "1," the brackets are just cut from strips of $\frac{1}{16}$-in. or 3/32-in. sheet steel respectively. Here is a tip which might save beginners some heart-burning. Cut your strip of steel to full length, and make the top bend first; then mark off the centre of the slot, $\frac{7}{16}$ in. or $\frac{5}{8}$ in. from the top of the bend, according to size of engine, set out the slot, mark off and centre-pop the holes for the guide-bar spigots, and the outline of the bottom curve. Then cut to outline, and drill the holes, you'll be certain that the bars will be supported at the correct level from the underside of the running-board.

Take Your Choice

To show the difference (which isn't much !) between a cast and built-up bracket in $2\frac{1}{2}$-in. and $3\frac{1}{2}$-in. gauge sizes, the former is shown built-up, and the latter cast, the choice being up to the builder. The main part of the $2\frac{1}{2}$-in. bracket is sawn and filed from $\frac{1}{8}$ in. soft mild-steel, to the sizes given. The flange by which the bracket is attached to the frame, is a piece of $\frac{1}{8}$-in. × $\frac{5}{16}$-in. mild-steel, $\frac{5}{8}$ in. long, with two No. 30 holes in it, for $\frac{1}{8}$-in. or 5-B.A. bolts. This can be brazed to the top of the bracket, at right-angles to it, by clamping temporarily in position with a home-made cramp; or a $\frac{1}{8}$ in. × 5/32 in. step can be formed at the top of the bracket, and a slot of similar size cut in the flange, the two being fitted together as shown in the detail sketch, and brazed. The lugs for supporting the bars, are bent up from strips of 16-gauge steel, $\frac{3}{16}$ in. wide, and brazed to the brackets. They are drilled No. 41 for the screws, but will not be fixed to the bars until the cylinders are erected. Built-up brackets can be made for the $3\frac{1}{2}$-in. gauge engine in exactly the same way, using $\frac{3}{16}$-in. steel plate for the main part of each bracket, and pieces of $\frac{1}{2}$-in. × $\frac{3}{16}$-in. bar, $\frac{7}{8}$ in. long, for the fixing flanges. The lugs are made from pieces of $\frac{3}{8}$-in. × $\frac{1}{8}$-in. angle, $\frac{1}{4}$ in. long, filed to suit the depth of the bracket below the bottom bar. Flanges and lugs can be temporarily pinned or clamped in position, and brazed.

If castings are used, which I recommend in the $3\frac{1}{2}$-in. size, they will only need cleaning up with a file, to the given dimensions, and drilling for the screw and bolt holes. Cast brackets can be ribbed, which adds to their appearance, although it doesn't make the locomotive steam and pull any better !

Erection Notes

The smaller sizes of guide-bars are simply screwed home into the holes provided in the gland bosses on the back covers of the cylinders, care being taken to keep them parallel with the piston-rods, and the flats exactly horizontal and vertical, so that they will fit properly in the crosshead grooves. They should, naturally, be tight; but don't overdo it, and break off the screwed part in a desperate effort to get the bars set squarely. As to the screw-attached bars, just butt them tightly against the covers, and use the screwholes in them, as a jig to guide the drill when making the locating counter-sinks on the gland bosses. The $3\frac{1}{2}$-in. bars are attached by $\frac{1}{8}$-in. or 5-B.A. screws, and the 5-in. by 5/32-in. or 3-B.A. screws, round or hexagon heads as desired.

If the holes for cylinders in the gauge "O" and "1" frames are made exactly to half the dimensions of the $2\frac{1}{2}$-in. and $3\frac{1}{2}$-in. gauge holes, it will be found that they are a little too short to accommodate the steam chests, and they will have to be lengthened slightly. This is easily done, by taking a wee bit out of each end with a flat file. I'll deal with the erection in the next spasm, if all's well.

"Loy" Fabric Patch Repair Kit

Most of our readers are familiar with "Loy" plastic metal, which was reviewed in THE MODEL ENGINEER some years ago and has since become popular for many purposes in model engineering, including the building up of metal surfaces and filling blowholes in castings, also the repair of leaks and cracks in tanks, metal hulls, etc. In cases where large holes or depressions have to be filled in, a foundation in the form of unpregnated fabric can be used to reinforce the plastic metal. This is now available as a separate kit, complete with a supply of special solvent which softens the fabric so that it may be moulded to the required shape and also renders it adhesive to metal, wood, or textile materials. The fabric can be used alone, or in conjunction with "Loy" metal, and dries quickly to metal hardness, after which it may be rubbed down or filed to smooth it or conform to the contour required and finally painted or enamelled.

We have used "Loy" metal and fabric for many purposes with complete and permanent success; it is specially useful for repairing a metal boat hull which has been dented or holed by collision with a concrete bank, and first-aid treatment in such cases is possible, as the metal sets sufficiently hard in an hour or two to enable the hull to be safely re-floated.

"Loy" products are manufactured by Douglas Holt. Ltd., Holborn, London, W.C.1, and obtainable from all engineers' stores and tool dealers.

CONVERTING A ROTARY TRANSFORMER

By "Duplex"

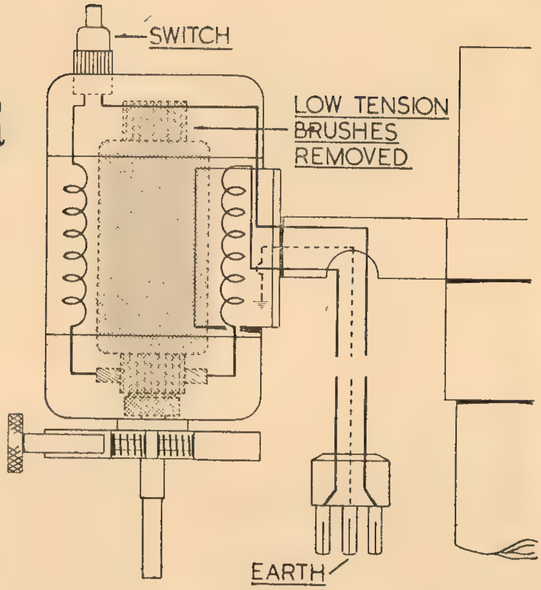


Fig. 1. Diagram of the wiring connections to the motor

THERE are several varieties of rotary transformers now being sold as war surplus material, and some of these make excellent small electric motors for driving from the a.c. mains.

The machine here described is a high-grade production of Messrs. Westinghouse, designed for a low-voltage d.c. input and having an output of some 220 V d.c. As shown in Fig. 1, the machine can be used as a motor by removing the low-tension brushes and then connecting the a.c. mains to the high-tension windings.

One of these machines when modified in this way has been used to drive the mechanical mixer recently described in these columns.

In a machine of this type, the armature shaft does not project beyond the bearings, and an extension has, therefore, to be fitted to the shaft if the machine is to serve as a driving motor.

One of these machines, obtained from an advertiser in this journal, had been furnished with a shaft extension consisting of a short spindle, threaded 6 B.A. and screwed into the end of the armature shaft. However, this extension-piece broke off as soon as the motor was put to work. The supplier is in no way to blame for this mishap, as he was quite unaware, when he advertised the machines, that the conversion has been carried out in this way. Nevertheless, these high-class machines are excellent value for the low price charged, which must be only a fraction of the original cost. There is, we found, no great difficulty in fitting a driving extension to the shaft, and the machine, after repair in the workshop, has continued to give satisfactory service. Unless the machine is required for only very light work, the extension threaded 6-B.A. is best removed and a stronger shaft substituted. For the latter purpose, the machine is dismantled by removing the brushes and the end-plates so that the armature can be withdrawn. Remove the extension fitted and also the ball-bearing and its dust cover, taking care not to damage the latter part, as it will be refitted later to keep the carbon dust from the brushes out of the ball-bearing.

Fitting the Shaft Extension

The method of repair is to discard the ball-bearing used with the 5/32 in. diameter shaft, and to fit a $\frac{1}{4}$ in. diameter extension sleeve to carry a new ball-bearing of corresponding bore. These standard bearings, with a $\frac{1}{4}$ in. diameter bore, are $\frac{3}{4}$ in. in outside diameter and 7/32 in. in width.

Machining Operations

The steel sleeve is turned to a light press-fit in the ball-bearing, and the 5/32-in. bore is formed by drilling and boring to a firm press-fit on the end of the armature shaft. The machining operations should be carried out at the same setting, in order to ensure concentricity. Before the sleeve is pressed home on the shaft, the dust shield must be put in place on the 5/32 in. diameter armature shaft. To obtain a secure fixing after assembly, the sleeve is cross-drilled to allow a well-fitting, 3/64 in. diameter silver-steel pin to

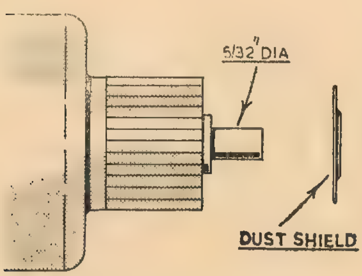


Fig. 2. Showing the original form of the armature shaft

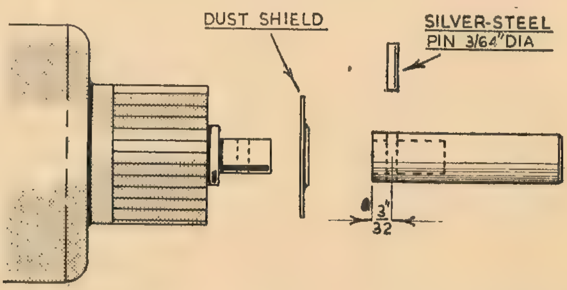


Fig. 3. Showing the method of fitting an extension shaft

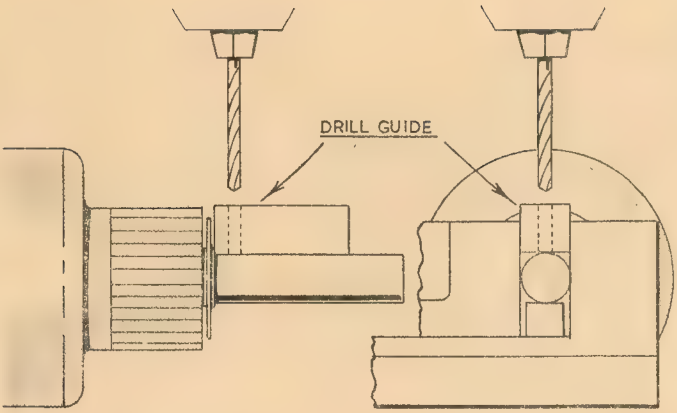


Fig. 4. Using a jig for cross-drilling the new shaft

be pressed into place in the vice. To ensure drilling this hole accurately across the sleeve and shaft assembly, it is advisable to use a simple jig, made by drilling a 3/64 in. diameter hole centrally in a short length of ¼ in. square material.

Boring the Bearing Housing

If a strip of thin card is placed on either side of the jig and the shaft, both parts will be firmly held when the jaws of the machine vice are tightened. After the outer dust cover or grease-retaining shield has been removed, the motor end-plate is centred in the lathe four-jaw chuck for boring out the bearing housing to fit the new ball-bearing. For this purpose, the endplate is gripped by its register, and the work is accurately centred by applying the reverse attachment of the test indicator to the inner surface of the bearing housing.

The housing is now bored out with a sharp tool to enable the bearing to enter as a light press-fit. A correct fit means working to a fraction of a thou. in., for if the housing is too small the bearing will be compressed and eventually damaged, whereas too large a housing will allow the outer race to rotate and slackness will develop. To obtain an accurate fit, a parallel mandrel can be turned ½ thou. in. larger than the bearing and, after the end of the work has been made slightly taper with a fine Swiss file or an emery stick, the mandrel is used as a fitting gauge for turning the bearing housing to size. Before trying the bearing in place, the sharp edge left on the housing should be removed with a scraper. When finally pressing the bearing into place, the pressure must be applied to the outer and not to the inner race. The outer dust cover is next bored out to 9/32 in. to fit over the new shaft and, after the endplate has been secured in place, the dust cover is fitted. It may, however, be found necessary to re-tap the holes for the screws securing the dust cover and the sealing ring, as the pressure of the ball-race may have slightly closed the threads.

If the work has been correctly carried out, the extension shaft will run truly and the armature will rotate freely.

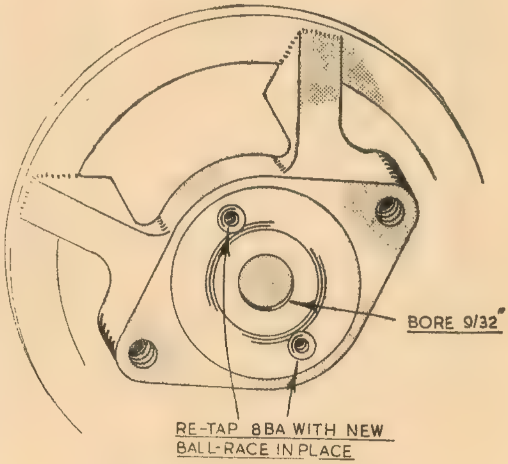


Fig. 6. Fitting the dust cover

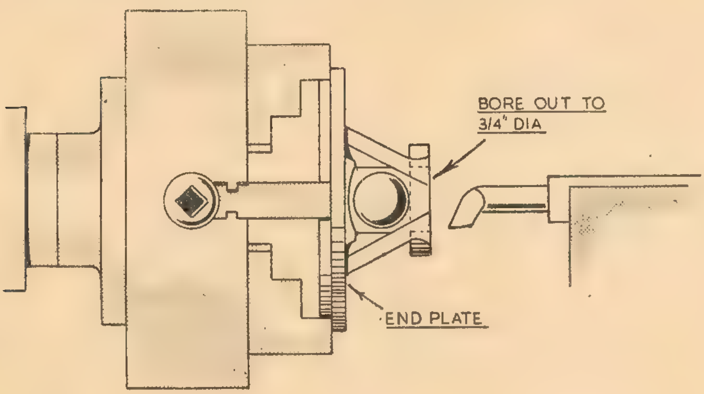


Fig. 5. Lathe set-up for boring out the bearing housing

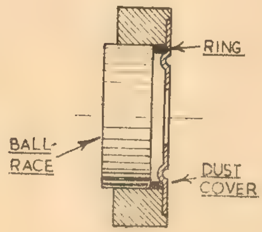


Fig. 7. Showing the outer dust cover and the sealing ring in position

British Railways Class 8 Lo

THE prototype engine of the Class 8 express passenger 4-6-2 type, No. 71000, *Duke of Gloucester*, first made its appearance at the exhibition of B.R. locomotives, rolling-stock and other equipment, held at Willesden in conjunction with the International Railway Congress. The engine caused surprise to many who saw it, since it was not what had been suggested, by rumour, previously. The basic design is almost identical with that of the Class 7, "Britannias," except for the Caprotti valves and gear, a double chimney, three cylinders instead of two, a 12 in. longer grate, and a very large 6-wheeled tender of L.M.S. pattern. The engine will probably be tried out and thoroughly tested, on the road as well as on the stationary testing plant, before being placed in regular service, in order to compare its performance with that of the other 4-6-2 type engines in use on British Railways.

A most interesting feature, new to British Railways, is incorporated in the inside connecting-rod and concerns the method of locking the big-end cotter. A specially serrated locking-plate is provided, the serrations being phased on both sides of the plate, in such a manner that four different positions of the serrations relative to those on the back edge of the big-end cotter can be obtained. This permits of an adjustment of 1/32 in. in the cotter position, and, since the taper on the cotter is 1 in 16, a final adjustment of approximately 0.002 in. is possible.

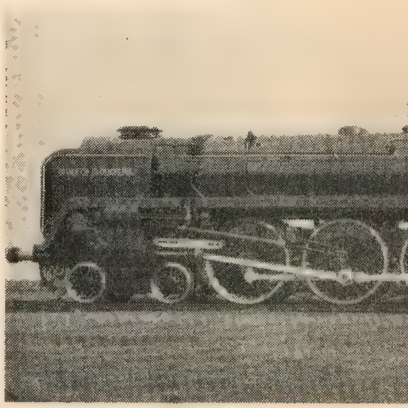
Another interesting feature is that the tyres of the coupled wheels, which are 6 ft. 2 in. in diameter, are shrunk on and secured by two small lips, one each side of the wheel-centre rim, there being no securing-ring, studs or rivets. Built-up weights in the wheels balance the revolving parts only. All the axles of engine and tender are mounted in Timken roller bearings.

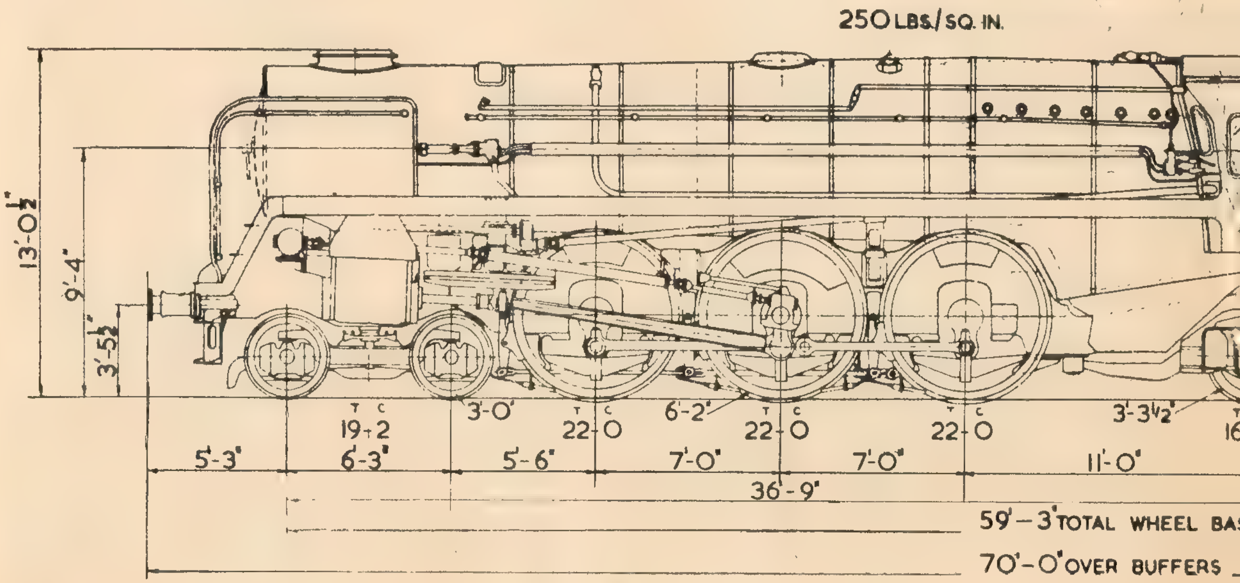
The boiler barrell is made in two rings, the forward one being cylindrical, the rearward one tapered; the outside diameter is 5 ft. 9 in. increasing to 6 ft. 5½ in. The length between tubeplates is 17 ft. The firebox, outside, is 8 ft. 0⅛ in. long, the width being 7 ft. 9 in. at the front and 7 ft. 4 in. at the back. There are 40 large flues, 5½ in. diameter, for housing the superheater elements, which are 1⅜ in. in diameter. The small flues, of which there are 136, are 2⅛ in. in diameter. The heating surface of the tubes is 2,264 sq. ft., and that of the firebox 226 sq. ft., so that the total evaporative surface is 2,490 sq. ft. The superheating surface is 691 sq. ft. The free flue area is 6.8 sq. ft.; the grate area is 48.6 sq. ft. and the working pressure is 250 p.s.i.

The three cylinders are 18 in. diameter by 28 in. stroke, and the estimated tractive effort is 39,080 lb.

The tender is of conventional appearance and has capacity for 4,725 gallons of water and 10 tons of coal. It runs on six 3-ft. 3½ in. wheels, the wheelbase being 14 ft. equally divided. The engine wheelbase is divided into: 6 ft. 3 in. plus 5 ft. 6 in. plus 7 ft. plus 7 ft., while the total for engine and tender is 59 ft. 3 in.

The weights in working order are: engine 101¼ tons; tender 55½ tons, totalling 156¾ tons. The minimum curve that the engine is allowed to traverse, subject to specified gauge widening, is 4½ chains radius.

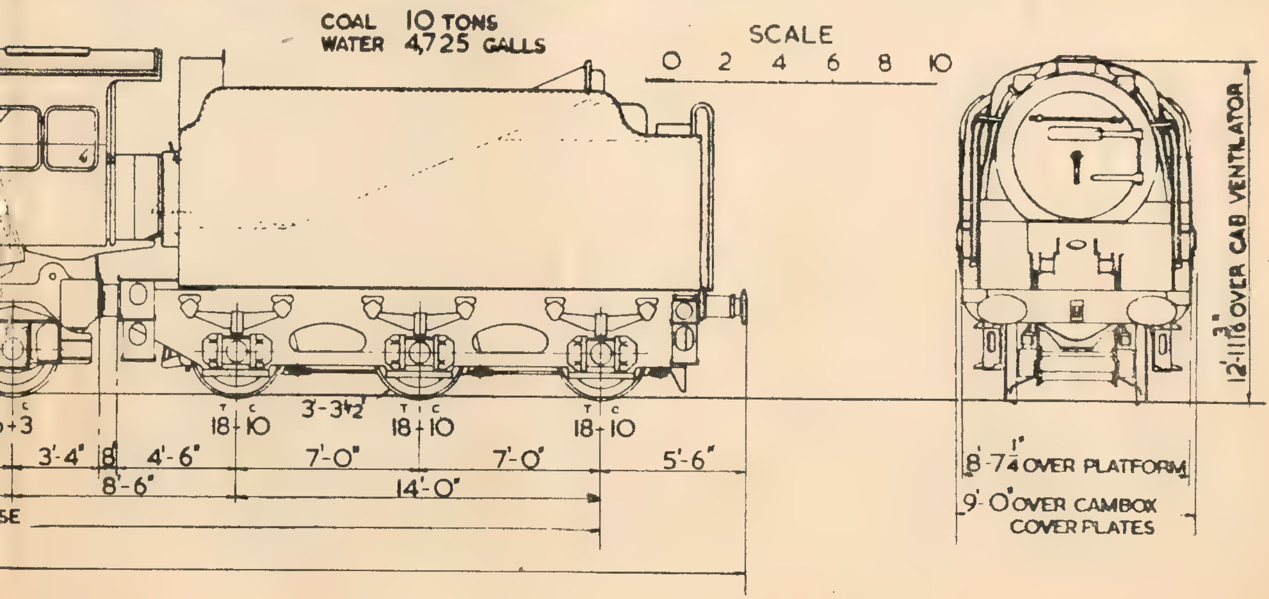




comotive

To the model engineer, this engine seems scarcely likely to appeal so strongly as the *Britannia*; the design and building of a cam-operated valve gear in a small scale, with any hope of its standing up to its work and, at the same time, looking anything like the gear fitted to No. 71000, still lies in the future. We are not suggesting that it cannot be done, for it is something that some petrol engine enthusiast would be almost certain to make successfully; but it would not be the simple, straightforward manufacturing job that a more orthodox mechanical valve-gear is, for the majority of model engine builders.

Boiler Barrel diameter (outside) ...	5 ft. 9 in. increasing to 6 ft. $5\frac{1}{2}$ in.
Firebox (outside)	8 ft. $\frac{1}{8}$ in. long x 7 ft. 9 in. to 7 ft. 4 in. wide
Tubes	40 large $5\frac{1}{2}$ in. O.D. x 7 S.W.G. 136 small $2\frac{1}{8}$ in. O.D. x 11 S.W.G.
Superheater elements	$1\frac{3}{8}$ in. O.D. x 9 S.W.G.
Length between tubeplates ...	17 ft. 0 in.
Heating surfaces: Tubes	2,264 sq. ft.
Firebox	226 sq. ft.
Total evaporative	2,490 sq. ft.
Superheater	691 sq. ft.
Free flue area	6.8 sq. ft.
Grate area	48.6 sq. ft.
Cylinders (three)	18 in. x 28 in.
Tractive effort	39,080 lb.
Adhesion factor	3.78
Brake percentage, engine and tender	51.17
Minimum radius curve ... ... (with specified gauge widening)	$4\frac{1}{2}$ chains
Boiler type	B.R. 13
Tender type	B R. I.E.



PETROL ENGINE TOPICS

The 50 c.c. "BUMBLE BEE"

A NEW DEVELOPMENT OF THE "BUSY BEE" AUXILIARY ENGINE INTENDED PRIMARILY FOR STATIONARY WORK

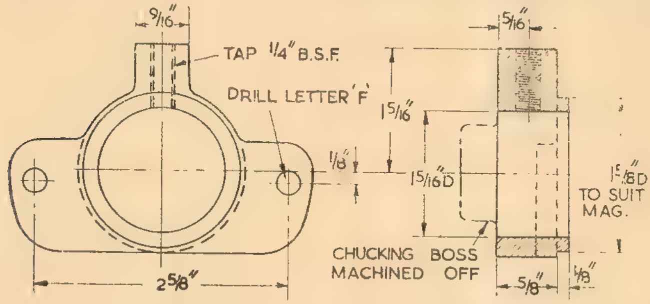
By Edgar T. Westbury

HAVING completed the crankshaft in accordance with the description given in the last instalment of these articles, it will be found that there is little difficulty in assembling the engine in such a way that the end journals line themselves up almost automatically. As already explained, the fit of the webs on the journals, and the flywheel end of the crankpin, should be sufficiently tight to ensure that they stay in place permanently, and it is only necessary to detach the other end of the crankpin to fit the connecting-rod, after inserting the half shaft into the crankcase. The other half should then be wrung on to the pin, assisted if necessary with light blows with a soft-faced hammer or mallet, and roughly lined up, but the cross bolt should not be put through yet. Next the endplates, with ball races and retaining plates in place, should be pushed over the shafts, and bolted in place; the ball races should not fit so tightly on the shaft that undue force has to be used, but the threaded ends of the shaft, with the aid of short pieces of tubing or old bushes, may be made to serve as drawbolts to ensure that the races go properly home against the spacing collars adjacent to the crank webs.

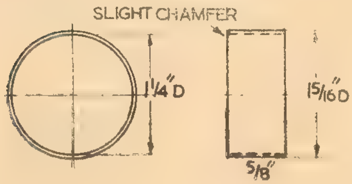
Continued from page 13, *July* 1, 1954.

The shaft should then be turned to see that alignment is correct; if it is tight, or lumpy, a few light blows with a mallet around the outside of the housings will usually jar it into alignment, or the two ends of the shaft may need torque applied in opposite directions to attain this result. The cross bolt can then be inserted from the inside of the crankcase by turning the shaft about 45 deg. from T.D.C., then as required for easy access to the nuts for tightening up.

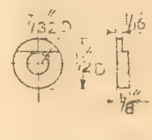
The counterbalancing of the crankshaft, as provided by the two integral balance weights on the webs, is heavier than that of the "Busy Bee," as befits an engine intended to run at a lower speed and with less, or more gradual, speed variation. As I have often pointed out, balancing of single-cylinder engines is always a compromise, and no rigid rules can be laid down, but generally speaking, it is advisable to balance out a greater proportion of the reciprocating forces on a stationary engine than on one which is mobile, and lightly mounted; the position in which the engine is installed also affects the issue to some extent, and tolerance to vibration in one plane may be greater than in others. In cases where troublesome vibration is encountered, slight alteration of the balance weights often has a considerable effect, but no balancing formula or system gives equally good results at all speeds and under all conditions on a simple single-cylinder engine.



Magneto mounting flange (1 *off, aluminium alloy*)



Seating sleeve (1 *off, aluminium alloy*)

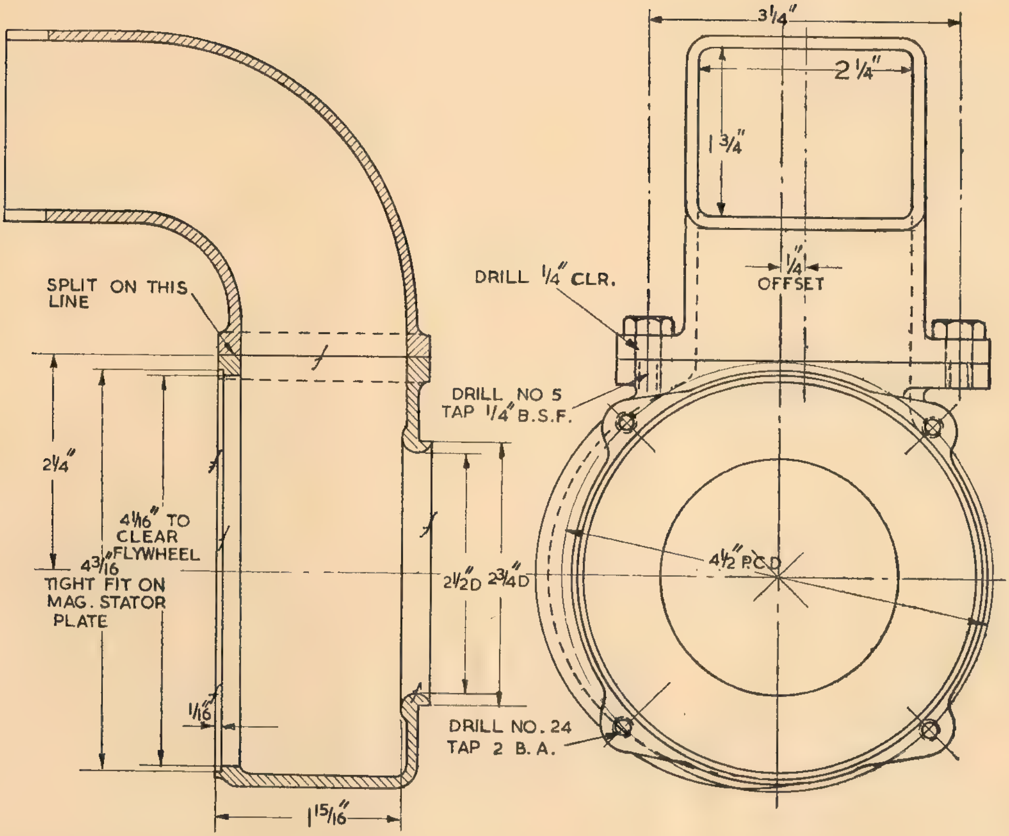


Magneto clamping discs (4 *off, duralumin*)

Magneto Mounting Flange

This is intended specially to carry the backplate of the Bantamag flywheel magneto as specified for this engine, and in the event of any other magneto or ignition system being employed, it may have to be modified or possibly discarded. It would not be necessary, for instance, in the case of the magneto which I described in the issues of THE MODEL ENGINEER, dated October 30th, November 13th and 27th and December 11th and 25th, 1952.

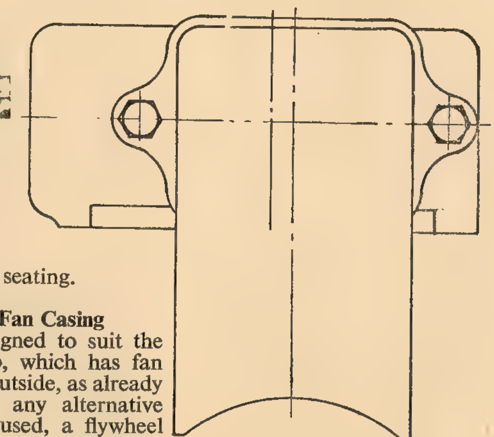
The machining of the casting is extremely simple, as it is provided with a chucking piece which enables nearly all the essential surfaces to be bored, turned and faced at one setting. In the case of the "Busy Bee" engine, the mounting flange is somewhat similar, but it incorporates also a ball race housing, and is bolted against a flange on the main housing; in this case it must be a friction fit on the spigot of the endplate housing. When once fitted and located, it does not have to move, but when two mating surfaces in aluminium alloy are in frictional contact, there is a risk of seizure in fitting them. To guard



Fan casing and air duct (1 *off, aluminium alloy*)

against this, a thin steel sleeve is pressed over the spigot to provide a seating for the bore of the flange; this may be regarded as an optional fitting, and personally I have not found it necessary, but my sophisticated professional friends advise me that it is "very bad practice" to make a wringing fit between two aluminium alloy parts. The sleeve is shown in the detail drawings, and may be made from steel tube if a piece of suitable size and gauge is available; it is essential that the inner and outer surfaces should be concentric. In the event of omitting this sleeve, the flange must, of course, be bored 1¼ in. diameter to fit the spigot of the housing direct.

Although the chucking piece is smaller in diameter than the bore, the machining can be finished at one setting, if the depth is limited to just the amount necessary, as the machining allowance on the back face will avoid cutting through at the back; the casting can then be mounted on a spigot mandrel for facing the back, when the chucking piece will be parted off. The set-screw which clamps the flange to the housing should not bear directly on the spigot or the sleeve, but should have a pad of fibre or soft metal inserted in the hole to avoid bruising the surface of the seating.



Cooling Trunk and Fan Casing

This also is designed to suit the Bantamag magneto, which has fan blades cast on the outside, as already mentioned, and if any alternative ignition system is used, a flywheel with similar fan blades will be needed, if the forced cooling system is to be retained. The trunk and casing are supplied as a single casting, and it is not necessary to separate them if a lathe large enough to swing the casting on the casing centre is available. But as many constructors will only have access to the usual small lathe of about 3½ in. centres, this part has been designed so that the trunk may readily be separated from the casing for machining the latter, and refitted by means of two bolts or set-screws through the flange provided. The joint line is indicated by a groove, and the flange may be sawn through at this point; but if this is not necessary, the lugs of the flange, on

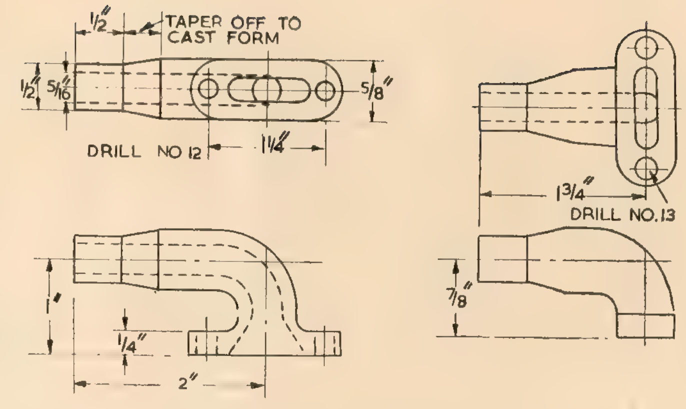
the other hand, may just as easily be sawn away. It is a good policy to drill the set-screw holes before sawing through the flange.

The casing may be held over the jaws of the self-centring chuck, by the inside of the air inlet aperture, for machining the back face, as this is only a light operation which does not call for a specially tight grip. It should be bored to fit tightly over the rim of the magneto backplate so as to ensure a true register. Although it is not necessary to machine the rim of the air inlet aperture it is worth while to reverse the casting, holding it in the same way for skimming this out and rounding it off with a hand tool.

To machine the top surface of the casing, to form a true seating for attaching the trunk, an angle plate on the faceplate may be used, but I found it easier to mount the casting on the cross-slide, holding it down by a single bolt through the centre, with a plate or large disc to span the aperture, and face milling the surface with a fly-cutter. The trunk flange can be similarly dealt with, by laying it on its side and clamping it with two bolts and a strap, packing it on the underside with cardboard, wood or fibre as necessary, to ensure that the flange face is vertical.

As no provision is made on the backplate of the magneto for bolting the fan casing on, it has been necessary to provide for this by fitting four studs or set-screws in the back-face of the casing, and using stepped clamping discs which will grip over the edge of the backplate. These may be turned and parted off from duralumin or other available material, as shown in the detail drawings, and the step may be either milled or filled, to a depth very slightly less than the thickness of the backplate; it may be necessary to remove, locally, some of the raised lettering on the latter casting to provide a true clamping surface. Shakeproof washers should be used under the nuts to guard against loosening.

It will be seen that the trunk is offset from the centre of the fan casing, so that when fitted in its proper position it conforms to the location of the *desaxé* cylinder. The mouth of the trunk is concave to embrace the cylinder fins and ensure that the air is directed on to them as effectively as possible; it should not actually touch the cylinder, and some filing may be necessary to give clearance. It is an advantage to fit duralumin or steel strips to stay the trunk to the cylinder head studs, but no details are given of these as they may, in some cases, be arranged



Alternative inlet pipe castings for vertical or horizontal engine mounting. (1 *off, aluminium alloy*)

so as to form, in addition, supports for a gravity-feed fuel tank.

Inlet Pipe

Assuming that a standard carburettor, such as the small Amal, or the special "Busy Bee" type, which has been described in the issues dated July 3rd, 17th and 24th, and August 7th and 14th, 1952. is fitted to this engine, an inlet pipe having a ½ in. diameter stub for clamping the carburettor thereto is fitted, and the design of this will depend on the position in which the engine is to be installed. If it is horizontal, the same inlet pipe as specified for the "Busy Bee" can be used, but the vertical arrangement will probably be the more popular, and for this a new inlet stub has been designed, with the fixing flange axis in line with that of the stub. The machining of this casting is quite simple, as it can be clamped to an angle-plate for both operations. The flange should be squared up by reference to the straight part of the pipe, but need not be centred accurately, as only a facing operation is required; the stub end will, however, have to be set to run as true as possible, for turning the end to a tight wringing fit in the carburettor socket, and boring out the cored hole as far as the straight portion permits. It is important that the end face of the stub should be true, and it should go right home in the socket when fitted, as otherwise there will be an air leak by way of the slot in the split clamp.

It is a good policy to clean out the bore of the bend, and also the flare at the flange end, by means of a riffler or rotary file, as a smooth passage improves the discharge efficiency of the pipe and removes any possible restriction to the flow. The area of the passage should *always* be greater than that through the throat of the carburettor at full bore, or good carburation at varying speeds is impossible.

The surfaces of the inlet pipe flange and its seating on the cylinder may be lapped to ensure flatness and it is quite possible to obtain sufficient accuracy in this way to avoid the need for any packing, except a smear of joint varnish. Generally, however, a gasket of very thin Hallite, Klingerit or other heat-resisting jointing material is advisable; avoid at all costs the use of thick and relatively soft gaskets. Many readers, no doubt will have seen the effects of using thick gaskets on motor car induction joints in the attempt to cure persitent air leaks; the flanges are nearly always distorted by the local bolt pressure into a concave shape, and the last state is worse than the first. The really important thing is to ensure that the surfaces are initially true, and use as thin a gasket as possible. This applies to all engine joints, but to none so emphatically as those of the induction system, where leakage is least obvious, but quite fatal to easy starting and smooth running.

One of the best jointing preparations I have used is known as "Wellseal," a product of Wellworthy's Ltd., and obtainable from most motor accessories dealers. It is equally suitable for use either with gaskets or metallic joints, and besides being impervious to oil and petrol, has the further merit of remaining plastic and tacky, instead of becoming brittle as most preparations of this kind seem to do.

(*To be continued*)

A Veteran Model Engineer

By "Hallam"

MR. JAMES HAWKES of Grangetown, near Middlesbrough in Yorkshire, is a man who has been building models for more than half-a-century: he started at the age of sixteen and is now turned seventy. A crane-driver for most of his 52½ working years, he retired through ill-health several years ago, but is still able to devote some time to the hobby if he takes care not to overdo it.

Like many model engineers who have had no formal mechanical training, Mr. Hawkes had to acquire his skill in the hard way, but his models prove that he was long ago successful in this. It is only during the past few years that he has had electricity at his service, so that most of his turning has been done by treadling, and his drilling by hand.

In nearly every case, his models have been built from scrap material, with very few castings; Mr. Hawkes is a firm believer in cutting things from the solid, and in the use of the file—he scorns milling set-ups. Almost all his work has been done without drawings, and has been based on familiar objects of his surroundings—steam-engines and locomotives of the huge steel works where he was employed, a paddle-tug on the River Tees, and so on.

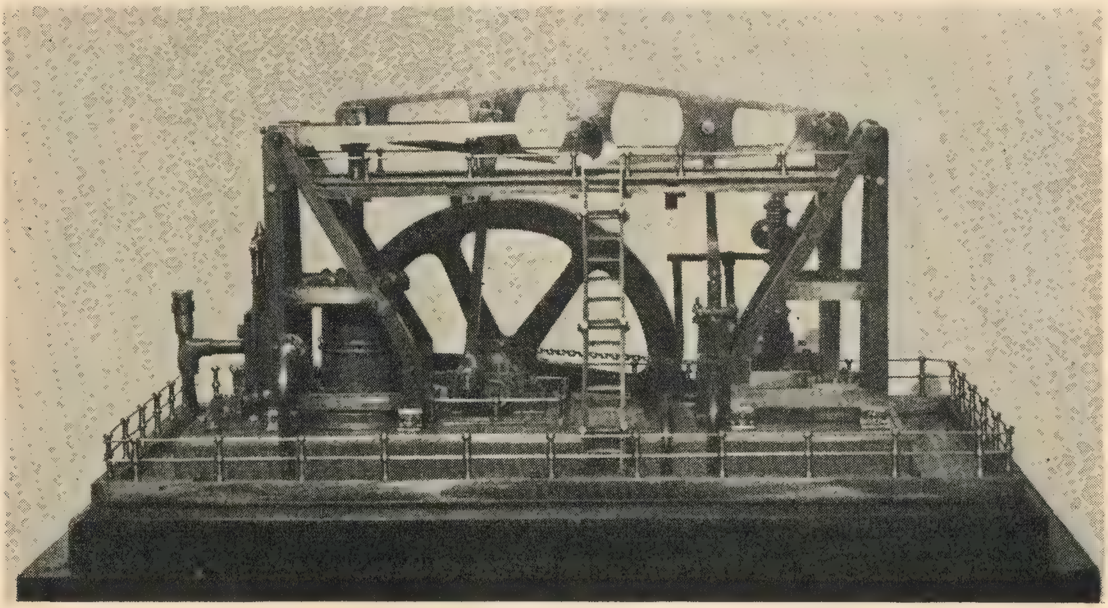
When I called on Mr. Hawkes recently to view his models, it was to spend a very interesting day, not only in this pleasant occupation, but in listening to his homely philosophy and enjoying his typically Northern hospitality. Mr. Hawkes not only showed me his work, but also insisted on demonstrating that the models all *did* work.

The First of Many !

The first model built by Mr. Hawkes was a small beam-engine, based on a prototype in the works. At that time, of course, he was a youthful and raw tyro, but even so the quality of the work was good, and the fitting excellent. Under a few pounds of air pressure, the flywheel rotates smoothly and the beam swings easily. The latter is made from double steel plate, and is 9-in. between centres, while the cast flywheel is 6¼ in. diameter. To work the valve, Mr. Hawkes used his own idea of a second rocking beam, to transfer the motion of the eccentric on the crankshaft to the valve-rod. The steel bedplate of the engine is about 13½ in. by 7 in. A locomotive-type boiler was used to steam the engine, fired by a "Torrid" burner; at that time, the builder had not sufficient knowledge to build a coal-fired one.

Another engine based on a work's prototype, and also coming early on the list, was a grasshopper engine, somewhat larger with a beam of 12 in. (outside) centres and a flywheel 9½ in. diameter. The latter was turned down from the hand-wheel of a hydraulic valve, and was drilled on one side of the rim to balance the reciprocating parts. The holes were plugged with aluminium faced off flush.

Cut from ⅜-in. steel plate, and polished all over, the beam is 2¼ in. wide at the centre. All the rods are fitted with split brasses, and the A-frames, also polished, are cut from ¼-in. plate. Incidentally, imagine the work in cutting those openings in beam and A-frames, in the time-honoured way by drilling



One of Mr. Hawkes' early models was this grasshopper engine, which like the beam engine, was based on a familiar prototype. (Photo by Brian Piper)

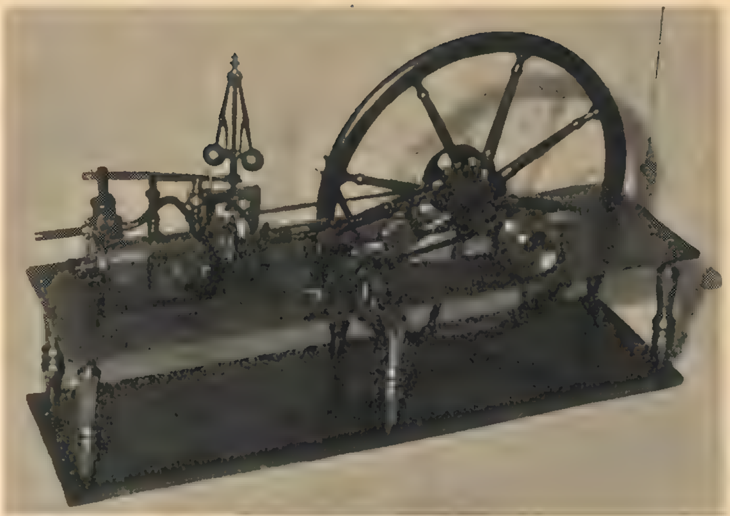
rows of holes (by hand !), by removing the pieces, and then filing to the line. Quite a job ! The hand-rail stanchions on this and other models are turned as "one-off" jobs, with hand-tools and not a form-tool, but it would take a very close examination to differentiate between one and any of its neighbours.

The prototype of this engine must have been getting on in years even fifty years ago, for the valve-chest is entirely separate from the cylinder, being connected to it only by the two steam-ways at the top and bottom.

An Old Horizontal Engine

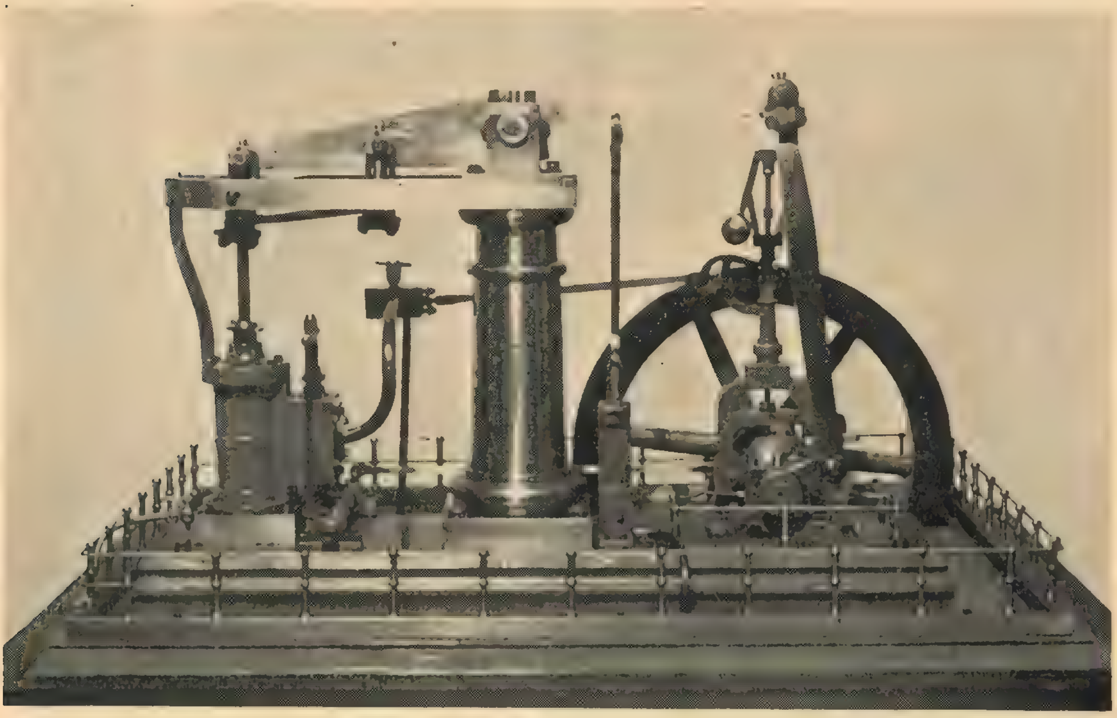
Next on the list was a model of an old-style horizontal steam-engine, with a bore of 1 in. and stroke of 2½ in. This has a built-up flywheel, 10 in. in diameter; the spokes are turned, with spigots pressed into holes in the hub or boss. The outer end of each spoke is filed to a dovetail, and force-fitted into a socket filed in the rim of the wheel. The rim is wrought iron, and on being struck rings with a clear, bell-like tone. It runs dead true.

A built-up cylinder is employed, with a very small valve-chest; Mr. Hawkes says it was quite a problem to work in the ports and passages. The slender piston-rod is extended past the cross-head, its outer end being supported by a bracket, and for this reason a forked connecting-rod has to be employed.



A delicate model of an old-time horizontal engine, with a built-up wrought-iron flywheel and forked connecting-rod

Stephenson link-motion is fitted, and the Watt-type governor is driven by lay-shaft from the crank-shaft, with bevel-gears at each end. The engine bedplate is supported on turned wrought-iron columns, and the whole construction is very light,



This beam-engine is larger than the first one, with a beam of 14-in., centres. The column was turned from a 4-in. shell forging. (Photo by Brian Piper)

including the motion-work. This is a dainty engine of pleasing appearance, and it runs well under a few pounds pressure.

A Larger Beam Engine

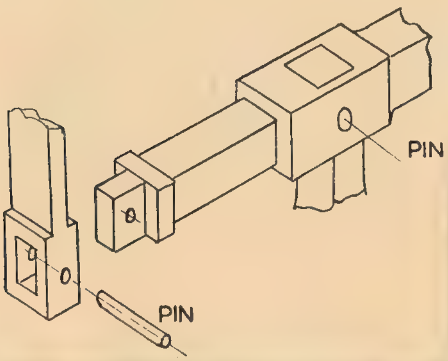
Now I was shown a more massive beam-engine, this time with an 11-in. flywheel, and a beam of 14 in. centres cut from steel plate $1\frac{7}{8}$ in. wide and $\frac{1}{2}$ in. thick. That Mr. Hawkes is, or was, a glutton for work is evidenced by the column of this engine, which at its maximum diameter (near the square base) is $3\frac{1}{2}$ in. It was turned from a " dud " forging for a 4-in. shell of the Kaiser war—on a treadle lathe, don't forget ! Further evidence, if any is needed, is given by the entablature which supports the links for the parallel motion. This was cut out of a solid piece of plate $10\frac{1}{2}$ in. long, $3\frac{3}{16}$ in. wide, and $\frac{3}{4}$ in. thick; again, it was all done by man-power alone. It makes me sweat just to think about it ! All the joints of the parallel motion, and the connecting-rod, are fitted with split brasses which are correctly wedged and cottered. The pillow-blocks for the beam-gudgeon and the crankshaft are also fitted with split brasses, and are cut from solid steel, as is the table supporting the governor. The cylinder and flywheel are the only castings employed, as they are on the next model to be described.

A Model Table Engine

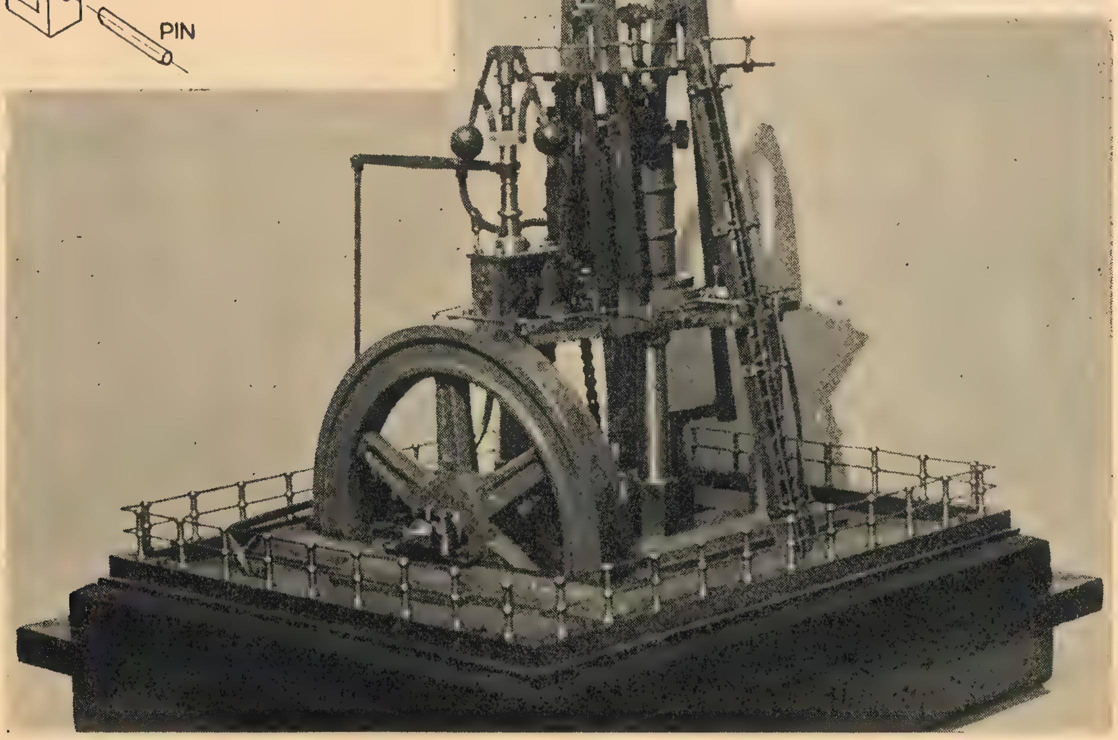
Still another steam-engine to be demonstrated on the compressor—and it ran as well as did all the others—was a steeple engine of $1\frac{3}{8}$ in. bore and $2\frac{7}{8}$ in. stroke, with a heavy flywheel 10 in. in diameter. This engine too was based on a prototype in the steelworks. The baseplate is $14\frac{1}{4}$ in. by $17\frac{1}{2}$ in., the table is 6 in. high, the upper platform 6 in. higher, and the slides reach $5\frac{1}{8}$ in. above that. Supported on turned steel columns, the table is $5\frac{5}{8}$ in. by $5\frac{3}{4}$ in., and is cut from $\frac{5}{16}$-in. steelplate. Besides carrying the cylinder and the slides, it also supports the massive governor, which is driven by chain from the crankshaft.

In an engine of this type, of course, the piston drives upwards to a crosshead, from which twin side-rods drive down to a crosshead to which the short connecting-rod is attached. In Mr. Hawkes' model, the side-rods are filed up from $\frac{1}{2}$ in. by $\frac{5}{16}$ in. steel bar, and the crossheads from $\frac{7}{16}$ in. square bar.

The sketch shows how the lower joints are made, with filed tenons fitting into filed mortises, which are then pegged. This is just another example of the delight that the builder



Left: Method of joining side-rods to lower cross-head of steeple engine



Based on another steel-works prototype, this table engine stands more than 17-in. above the bed-plate.
(Photo by Brian Piper)

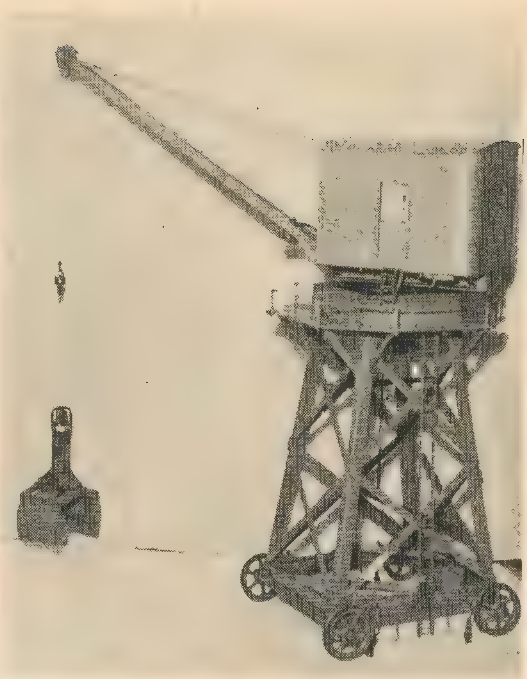
finds in hand-fitting—and why not ? Skill such as this is not achieved by everyone, and the pleasure attained is in proportion to the achievement, in our hobby as in others.

An Electric Wharf-side Crane

Now, as a change from steam, I was shown a model of a crane which Mr. Hawkes drove for many years. This was a three-ton wharf crane, fitted with an automatic sand-grab. Built to $\frac{3}{4}$-in. scale, the model stands over 3 ft. high. The framing is cut from old scrapped stair-treads of brass, and is bolted together as in the prototype. A wooden cabin houses the mechanism; it is correctly framed inside, and the fittings include a small metal stove, which is even complete to the firebars. The cabin-door is of the two-part " stable " type, hinged and having the correct snecks and bolts.

Separate motors are used for the slewing and lifting; the jib cannot be luffed, and the crane is not self-propelling—on the wharf the big crane was hauled about by a steam locomotive. The motors on the model are rather over-size, and are powered through a transformer, as are the cabin-light and the floodlight attached to the jib. Current is taken to slip-rings on the king-post, and is picked up by brushes as the cabin is slewed.

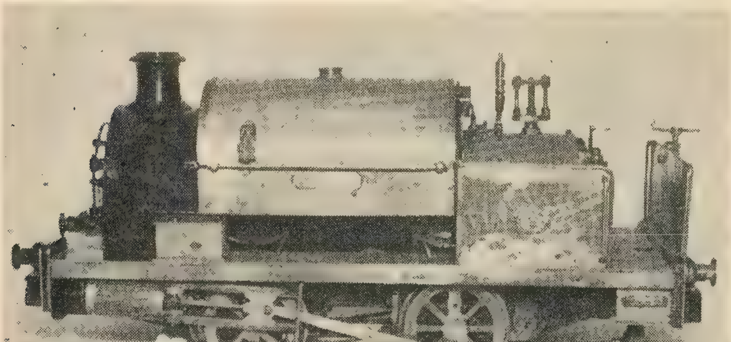
The lifting motor drives the winding-drum through gears; the drum is built-up, and has turned grooves for the rope. As mentioned, the sand-grab is automatic in operation, and it works as follows. The drum is disengaged from the drive, and the grab falls, controlled by a foot-brake. As it strikes the sand, this releases a catch, and the impact opens the jaws, which dig into the sand. Winding now being commenced, the jaws close on a load of sand, which is lifted and slewed to a wagon. Allowed to fall again, the jaws open and dump the sand in the wagon.



An electrically-powered wharfside crane, fitted with automatic sand-grab. Mr. Hawkes drove the prototype for many years

An Industrial Saddle Tank

Coming back now to steam, a 5-in. gauge saddle-tank locomotive was next on the list. The model was built by Mr. Hawkes more than forty years ago, and the prototype was a work's locomotive built by Black and Hawthorne in 1883. The boiler is of the Smithies water-tube type, with a " wet " backplate, and is fired by oil. It is riveted and soft-soldered from copper and of course is encased in a replica of the real thing.



An inch-scale model of an industrial tank locomotive built by Black and Hawthorne in 1883

Brass was used in casting the wheels—which was done by the builder—and the motion work is brass too. Stephenson link reversing-gear is used, and the connecting- and coupling-rods have split brasses. The locomotive rides on leaf-springs made from a clock-spring, and is fully-detailed; working brake- and sanding-gear are fitted. She has pulled more than 3 cwt., and is still in good working order.

(*To be continued*)

How to Use Hacksaw Blades

A useful and instructive booklet on this subject has been issued by Messrs. James Neill & Co. (Sheffield) Ltd., Napier Street, Sheffield 11, the makers of " Eclipse " hacksaw blades, with the object of assisting all users of blades to obtain maximum efficiency and economy in their use, whether in hand frames or machines. Advice is given on the selection of the type and size of blade most suitable for particular classes of work, the influence of the tooth size and spacing, flexible and rigid blades, and the advantages of high-speed steel blades for continous work and for sawing alloy-steel or other tough materials. This booklet can be obtained free on application to the above address.

Accurate Working with the Chuck

By "Boggler"

THE model enthusiast who has just purchased a brand new three-jaw self-centring chuck, removed the various layers of greasy paper and sat gazing at the handsome and shiny piece of mechanism, will no doubt be thinking that at last here is the answer to really getting on with the model in hand; after all, the makers have guaranteed it to hold round stock concentric to within one thousandth of an inch, and for the first time, it will be possible to chuck hexagon bar to get those bolts made in real luxurious comfort. Three cheers for three-jaws!

Doubtless, after the chuck has been carefully fitted to its backplate, the anticipated results will be obtained, but after a period, which will vary from a few months to a few years, according to the amount of work and use to which the chuck is put, certain undesirable errors will make themselves apparent: First, usually on assembly of a piece of work which has been made with the help of the chuck, whilst later the chuck will be so far " out " that there will be a noticeable wobble or eccentric motion imparted to work held in the chuck.

The writer has suffered from these chucking troubles, but has been able to find a cure for most of them.

First, it is reasonable to say that these faults which develop are very rarely due to bad workmanship during manufacture, most working chuck parts being made from special hard wearing alloy-steel, to very close limits.

One method of approach to the problem, adopted by the writer, may come as rather a surprise to those not already familiar with the idea, in that it consists primarily, in the removal of the register from the backplate.

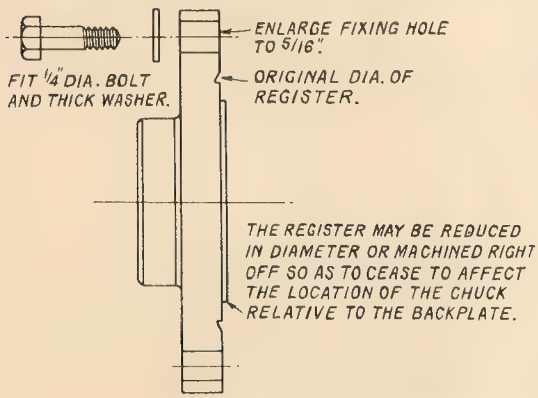


Fig. 1. Backplate, showing treatment required

Reference to Fig. 1 will give an idea as to what the backplate should look like after treatment. The register should be machined away, or reduced in diameter so as to have no further effect in the location of the chuck relative to the backplate. The usual three fixing holes should be enlarged so as to allow for a small movement of the fixing bolts within the holes, and a fairly thick washer should be provided for each fixing-bolt, so that the washers do not get "dished" into the holes, which might happen to a thin washer, as the holes are oversize.

If the chuck has been fitted with hexagon socket-head cap screws, it would be an advantage to change these for ordinary hex. heads, since, if it is desired to adopt the system being described, these screws will have to be frequently adjusted, and owing to their location it is easier to use an ordinary spanner.

Assuming the above alteration to the backplate has been carried out, the backplate can be re-attached to the chuck, leaving the fixing-bolts a little more than finger-tight, and the whole screwed on to the lathe spindle nose, whereupon, in order to re-set the chuck to the best advantage for average work, a piece of, say $\frac{3}{4}$ in. diameter bright mild-steel (do not use silver-steel, as it is seldom truly circular) may be gripped in the jaws (Fig. 2) and the dial indicator mounted on the cross-slide, or top-slide, so as to obtain a reading from the test-piece; then, by rotating the work, the clock needle will indicate in which direction the chuck body needs to be tapped to get the test-piece to revolve concentrically, after which the chuck fixing-bolts can be tightened with the spanner.

To set the chuck in cases where some sort of test indicator is not available, a piece of steel which

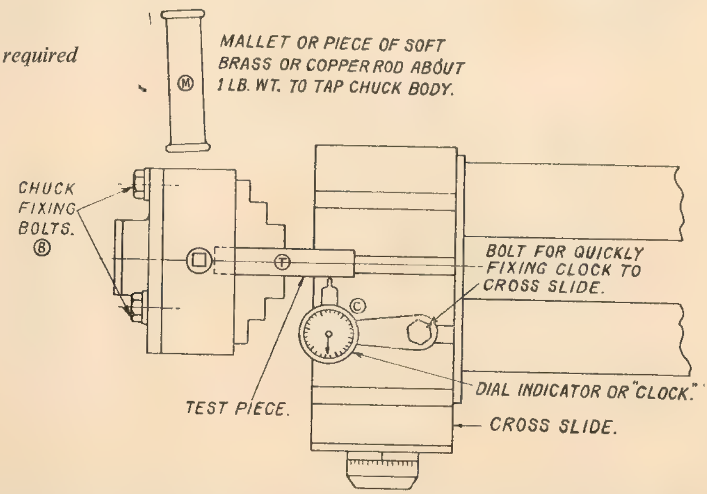


Fig. 2. Set-up for setting chuck for average work. With B just over finger tight, rotate chuck by pulling belt. Read error on clock C, correct by tapping chuck with M. Tighten B

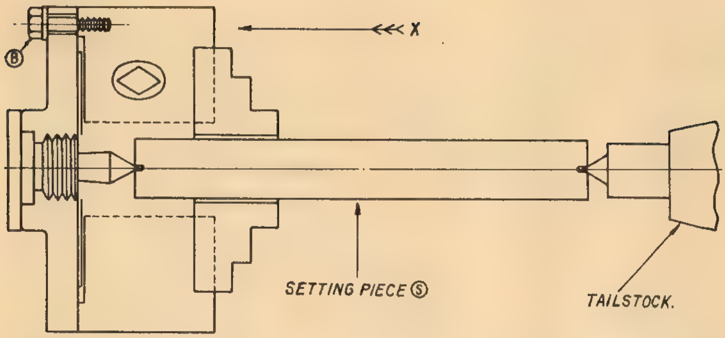


Fig. 3. To set chuck for average work without " clock." Mount setting bar S between centres, with bolts B slack, push chuck in direction of arrow X, tighten jaws on to bar S. Body of chuck will move to suit position taken up by jaws. Tighten bolts B

has been previously machined between centres, may be mounted between centres (Fig. 3) and the chuck jaws closed down on to that; in this case the fixing screws being barely finger-tight to allow the body of the chuck to move rather more freely, as it will when the jaws are closed. When the chuck has been set by either of the above means, the fixing-bolts should be tightened, and the chuck will be ready for a variety of work where only moderate accuracy is required.

Of course, the method of setting shown in Fig. 3 presupposes that the headstock centre is already true. If there is any doubt about this, it would be as well to set the top-slide and take a truing cut.

In special cases, as for example, where it may be desired to re-chuck a number of fully machined bushings, all of the same outside diameter, with a view to opening out the bore whilst maintaining concentricity with the outer surface, the chuck fixing-screws should be slackened as before, the bush gripped in the chuck, and the outer surface " clocked " true (see the set-up in Fig. 2) when, after re-tightening the chuck fixing-screws, the proposed boring may be safely carried out. Where a number of bushings require such treatment, this method will be found to be quicker than working with the four-jaw independent chuck, although, if accuracy in the region of plus or minus 0.00025 in. is required, the independent chuck had better be used.

It should here also be remarked that to set the chuck for the boring of the bushings, when an indicator is not available, a mandrel or setting-bar may be turned between centres, this bar to carry a step, about 2 in. in length, of the same diameter as the outside diameter of the bushings. This may then be used to set the chuck as in Fig. 3.

Thus, it will be seen that, essentially, the idea is to allow the work to revolve truly, any error in the chuck being transferred to the chuck body, where, unless the chuck is badly " out," or very high speeds are used (speeds in excess of 1,000 r.p.m.) the eccentric movement of the chuck body will do no harm.

Objection has been raised that the chuck might slip or move relative to the backplate under cutting conditions. The writer has had two 4 in. three-jaw self-centring chucks (to eliminate time otherwise wasted in reversing jaws) in use for about 13 years, and the only time the chuck moved relative to the backplate, was when a final spanner tightening had been overlooked, and the fixing-bolts were left just a little more than finger-tight; even then, considerable work had been carried out on a component before the chuck shifted. After all, if due consideration is given to the matter, there is available quite a large frictional area of contact between the backplate and a 4 in. chuck, and the alteration can be made with every confidence.

In many cases, an apparent error in a chuck can be traced to turnings, brass and cast-iron dust being especially liable to get inside to the scroll when the jaws have been opened far enough to expose part of the latter, as for boring a bushing of fairly large diameter; therefore, the chuck should be frequently taken to pieces and cleaned. It is appreciated that the model engineer, with his limited spare time, is not keen on holding up production to clean chucks, but it does pay dividends in the end.

If the gripping surfaces of the

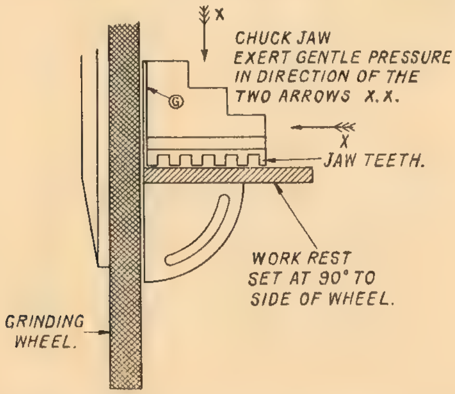


Fig. 4. Truing chuck jaw by very lightly grinding the normal gripping surface G on side of wheel

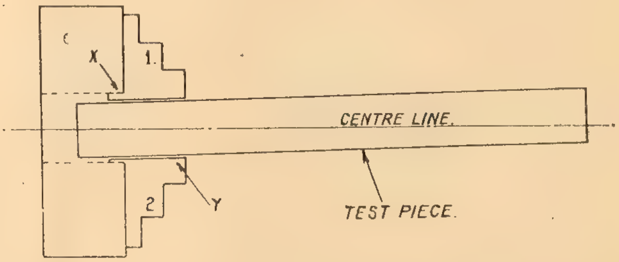


Fig. 5. Exaggeration illustrated of one type of 3-jaw chuck fault. Jaw No. 1 needs more grinding off at X than in front. Jaws 2 and 3 need more off front ends Y. A cigarette paper placed under jaw teeth (Fig. 4) would tip the jaw forward or back in order to remove metal from the desired point

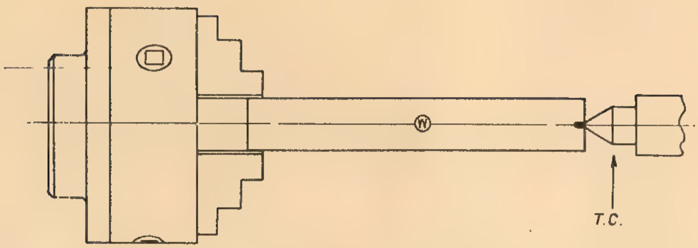


Fig. 6. "Chuck and Centre" working. To obtain the best results, first lock tailstock centre in approx. position, place oiled centre hole of work W on to T.C. Pass other end of W between chuck jaws and, pushing W towards T.C., tighten chuck jaws

chuck jaws are badly worn, they may be removed, and with the off-hand tool grinder work-rest set at right-angles to the side of the wheel, Fig. 4, the worn gripping surface of each jaw may be ground on the side of the wheel, until, by repeated trial, the chuck is again gripping work in a reasonable manner. It must be said, however, that this latter operation is not one that should be undertaken by the inexperienced, in that there is more than one way in which the jaws can be at fault.

For instance, whilst the jaws may be treated so that a short test-piece might show only a small permissible error on the clock, substitution of a piece about 12 in. in length might, on rotation, indicate a conical stirring motion, the work, in fact being held as in Fig. 5, but unhurried inspection and careful thought will indicate which jaw or jaws require further treatment. Of course, great caution should be taken when grinding the jaws in this manner, only very light "sparking" cuts being made; it is surprising how little usually need be ground from the jaws to make an improvement.

Should the jaws need correction for the fault shown in Fig. 5, where jaw No. 1 requires the removal of metal from point "X," the work rest (Fig. 4) should not be re-adjusted but a cigarette paper should be placed underneath the jaw teeth at the end nearest to the wheel, this will have the effect of tipping up the jaw so that the bottom left-hand portion gets ground first. Before undertaking this grinding treatment, the chuck should be taken to pieces and cleaned, otherwise you are liable to be correcting errors caused by dirt, whereupon, when the chuck is finally cleaned at some later date, it will be found to be "out"!

Having carried out the above corrective treatment on his own chuck, the writer feels that it is in many ways a better method of approach than the more usual one of locking the jaws in some way and internally grinding with a grinding attachment. The chief reason for thinking this being that, with the individual jaw treatment, the chuck is corrected under working conditions.

In cases where the chuck is very old, the corrective treatment detailed in Figs. 4 and 5 will probably do some good, but it will be found that the chuck will have to be set, or re-set, concentrically for each job, the average setting being of no use unless errors of plus or minus 0.004 in. to 0.008 in. are not objected to, over a range.

It will be found to be very convenient to arrange some means whereby the dial indicator can be readily and quickly mounted on the cross-slide, or top-slide (if you use the latter, I seldom do) with the indicator point at exact centre height. This encourages its use on almost every job, with very beneficial results.

In conclusion, whilst on the subject of self-centring chucks, perhaps a few words on "chuck and centre" working (Figs 6 and 7) would not be out of place. A fact which does not seem to be generally appreciated is that when working with the three-jaw self-centring chuck, and tailstock support has to be given owing to the length of the component, the work is best mounted as in Fig. 6 where it will be noticed that the chuck jaws are only gripping a small length of the work. This is important, in that it minimises any error, such as that in Fig. 5, and relieves the component of possible strain. In setting up the work *W* as in Fig. 6, the tailstock should first be adjusted and locked in the approximate position required, after which the centre hole in the work should be pushed against the tailstock centre, and the chuck jaws opened out sufficiently to allow the work to pass sideways between them, then, whilst holding the work against the tailstock centre, the chuck jaws may be closed. As, under these conditions, the closing of the chuck jaws tends to force the work more tightly against the tailstock centre, this should be slackened and re-adjusted, not forgetting the oil. Finally adjust the chuck as in Fig. 2.

Fig. 7 illustrates a similar "chuck and centre" job, but here, as heavy cuts are anticipated, it is a good idea to arrange some sort of work-stop inside the chuck. The writer uses a No. 2 Morse taper threaded ¼ in. B.S.F. into which can be threaded suitable lengths of screwed rod, locked by a nut. This form of stop very effectively prevents the work working its way into the chuck and leaving the tailstock centre, under pressure of the cut.

It is appreciated that we are "not supposed" to work between chuck and centre, but the writer prefers it for many jobs, as, for one thing it is safer, in that no carrier is required, and these are always a source of danger; however, now that you can "bash" your chuck true, what matter?

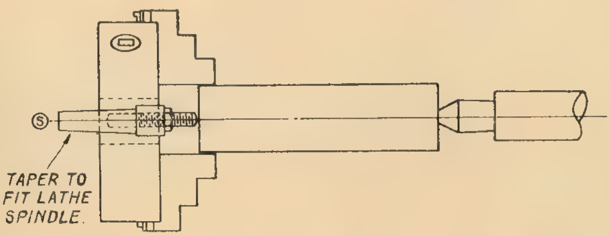


Fig. 7. "Chuck and Centre" working. Where heavy cuts are anticipated, a stop S is useful in that it prevents the work moving into the chuck, and leaving the tailstock centre, under the pressure of the cut

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

A MODEL STEAM PLANT

DEAR SIR,—Referring to the letter from Mr. F. Rayner, of Cape Town, South Africa, published in THE MODEL ENGINEER dated May 20th, 1954.

I am afraid I can throw no light on the origin of the engine mentioned in your correspondent's letter, but on seeing the illustration I immediately identified it as being the same type as fitted in a motor launch purchased by my brother, Mr. Denis Marshall, some two years ago.

My brother has, at my request, very kindly taken photographs of the engine and boiler, and the boat in which it is fitted and furnished me with copies. There is every reason to believe that the boiler is the one intended for use with that particular engine. This boiler is of a very simple type, fabricated from sheet brass, half-round in shape, with a lap joint underneath and flanged ends, the joints being sealed with ordinary soft solder. The steam pipe is brought underneath the boiler to the engine, and runs just above the flame of the spirit lamp. A simple spring-loaded safety-valve is fitted.

The boat is 39 in. long, of plywood construction, and fitted with radio control.

I am informed that the performance of the engine is excellent. It idles very steadily and has plenty of power under steam. On one occasion the boat was tried out in the local foreshore bathing pool under conditions of very rough weather, and although it was feared after the start that the boat would be swamped by the combined force of wind and wave, the engine gave enough power to take it safely across the pool.

If any further details are required we shall be happy to assist in any way possible.

Yours faithfully,

Jersey, C.I. W. H. MARSHALL.

LAPPING METHODS

DEAR SIR,—Your contributor, "Duplex," has given bad advice to would-be lappers. With the devices given on page 565, if the lap suddenly seized, as they often do, it would cut the hands of the operators in shreds. I can speak with authority, as I was a gauge maker with Sir Hiram Maxim at Crayford, at the Royal Small Arms factory at Enfield, and also, at Vickers Ltd., at Erith. For seven years I was superintendent at C.A.V. Tools Ltd., Hove. The ideal laps are made either of lead or type metal bored out to fit the work, and are usually 1 in. wide approximately, and about $1\frac{1}{2}$ in. larger than the gauge to be lapped. The gauge should be cylindrically ground and the amount left for lapping about 0.0005 in. to 0.001 in. The laps should have a wide saw-cut through one side, and when wear takes place they are closed in by hammering around the periphery, when they will close in—and *no* handles are necessary.

On another point; in Mr. Gregory's letter re centreless grinding. It is impossible to make anything round when ground this way, except where the work-piece is perfectly cylindrical *before* grinding. It will be seen that centreless grinding takes place in a vee-block and the abrasive wheel pushes the work-piece into the vee and at the same time causes it to rotate.

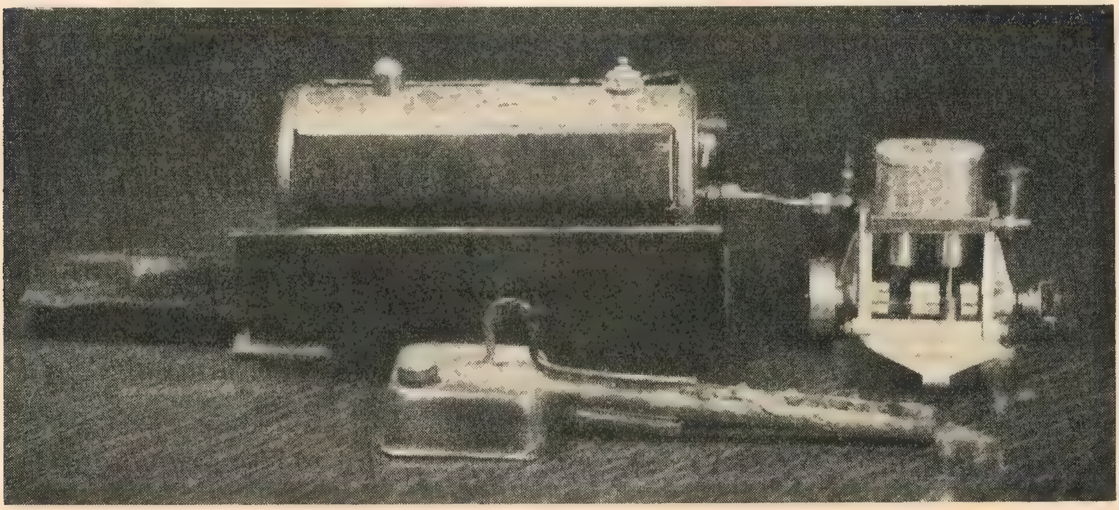
Whilst I was chief inspector at a works at Cricklewood, I demonstrated this to the work's manager, by putting a gudgeon-pin, just ground, into a good fitting ring gauge, which showed that it was touching on three points. It is impossible to detect this with a micrometer, the reason being obvious.

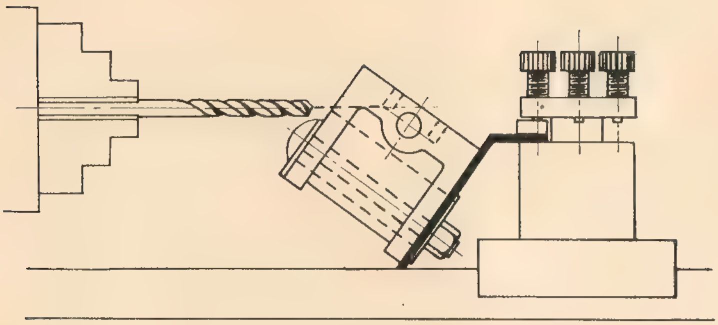
Yours faithfully,

Hove. JAMES PEARMAN, A.M.I.P.E.

DRILLING CYLINDER PORTS

DEAR SIR,—Whilst machining the cylinders of a $\frac{3}{4}$ in. "Warrior" marine engine, the problem arose how to drill the steam passages from the cylinder bore to the port face. The ports had been milled to the correct depth, but there was no bench drill with which to drill these holes in the approved manner (as described in THE MODEL ENGINEER). So the following idea was hit upon, which the sketch will help to make clearer. A piece of $\frac{1}{8}$-in. sheet brass, or suitable similar plate, about 2 in. wide, is bent to the required angle, with sufficient length left at one end to be gripped in the slide-rest tool-holder, and the other end to just rest on the lathe bed, to prevent





any whip in the plate when the pressure of the drill is applied. The cylinder is bolted to the plate as shown, and properly adjusted—a hole having been drilled through the plate to take the bolt. With a drill in the three-jaw chuck, the holes can then be drilled dead true by movement of the lead and traverse screws. As the cylinder face lies uppermost, the point of the drill can be watched for when it breaks into the ports. In this way the cylinders have been drilled with absolute accuracy and satisfaction.

If this is not in keeping with best engineering practice, please forgive me !

Yours faithfully,
Calcutta. J. H. BAYLEY.

STEAM ROAD VEHICLES

DEAR SIR,—Further to Mr. Blow's letter in June 3rd issue of THE MODEL ENGINEER, I had a Garrett tractor which had a habit of opening its regulator when the driver started to check her on the down hill with the reverse; this used to help one's progress considerably.

Now Mr. Wilson has found a 10-wheel Sentinel ! Unless somebody has made her into an articulated, I expect she is an S.6, as the Sentinel made 4, 6, and 8-wheeled wagons, and I believe were the first people to make the front four wheels to steer.

I run several Sentinels, two on tar spraying, one rebuilt last winter, one the winter before; two Sentinel D.G.4 timber tractors, which are used amongst other jobs for snow ploughing in the hills for the S.C.C. in the winter. Also four steam rollers, one or two Sentinels stood, and two traction engines.

I am a steam lover and intend to run some steamers as long as it is possible to find work for them. I find the Sentinel Model S wagon will do about 30 miles to the cwt. of Welsh coal, will cruise at 30 m.p.h., is a very much nicer vehicle to drive in traffic than an i.c. machine, and for tar spraying, one can warm up the spraying gear with steam. But they must have a driver who understands them, and is nearly a fitter; then they are most reliable. The chief snag is their unladen weight; when they carry enough water for 70-80 miles, a day's coal, etc., they are 7-8 tons; and that is with one of the last built before the war, 1938. I was running an S.4 tipper that was about 16 tons gross with an 8 ton load, then she was three times cheaper on fuel than a new 7-ton petrol lorry on the same run, and the steam did the same runs a day !

Yours faithfully,
Bucknell. R. M. WOOLLEY.

SCREW-CUTTING INDICATORS

DEAR SIR,—Your querist H. L. (Hull), does not say whether his dial indicator is a Myford or a home-made one, nor does he say whether he has succeeded in cutting any other pitch threads. A worm wheel whose teeth were not a multiple of the leadscrew t.p.i., would, of course, fail to cut any thread which was not itself a t.p.i. multiple. Being a number of complete threads to the inch, it should be possible to cut this thread at every inch mark on the dial.

I would suggest two other possibilities: (1) Clogged up threads in the split nut which, with the Acme thread form, permits an exceptional amount of backlash or float in the saddle, or (2) the Simmonds nut on the split nut locking lever is loose, permitting the nut to creep open during traverse and permitting the saddle to creep back relatively and thus altering the pitch.

Yours faithfully,
East Ham. A. E. CLAUSON.

FRIENDLY ADVICE FOR "CADET"

DEAR SIR,—In the interests of historical accuracy, and perhaps of paternal propriety also, I must refer to Mr. G. W. Vickerage's letter under above heading in your issue of June 17th, 1954.

We in Dublin would be very proud could we but claim that the Irish capital was the birth-place of the Model Engineering movement; but unfortunately we cannot, as we are only the eldest son of a large family. The father of all such Societies was the S.M.E.E. which, to the best of my knowledge, was founded in 1898, Dublin following the lead in 1901. The former date was supplied to me be our last surviving founder-member, whose death occurred some months ago. The latter year is confirmed by original minute books which have recently been traced.

Both Societies, as your correspondent says, survived two world wars; they also weathered many storms and passed through many vicissitudes, but surely they did survive not because they had a number of rank and file members, but because of the efforts of a relatively few enthusiasts, call them, if you will, "pillars" or "posts," "stanchions" or "columns." No, I must correct that—if "columns" preserved our Societies, it was undoubtedly those which have filled the pages of THE MODEL ENGINEER since No. 1 was issued.

Fraternal greetings from Dublin to our many younger brothers across the water, and the respects of all to our common father, S.M.E.E.

Yours faithfully,
Booterstown, Co. Dublin. JOHN J. CARROLL. *Hon Sec., D.S.M.E.E.*

Next Week . . .

SCREWCUTTING WITHOUT TEARS
The oft-coveted luxury of a multi-change gearbox for the lathe is brought within the reach of model engineers in this constructional article by a South African reader.

"TITFIELD THUNDERBOLT"
The safety-valves have been safely disposed of, but there remain a number of simple, though essential boiler fittings to be made; they are dealt with in this instalment.

A VETERAN'S COLLECTION
The conclusion of our description of the remarkable collection of models owned by the verteran enthusiast, Mr. J. Hawkes, of Grangetown, Yorkshire.

MODEL BOILER FIRING
In the "Utility Steam Engine" series. details are given of a new type of diffused flame vaporising burner suitable for firing small water-tube boilers.

ELECTROFORMING
A practical method of producing small metal components for models by electro-deposition, without elaborate equipment.

HOME-MADE ELECTRIC POWER TOOLS
"Duplex" describes how a "surplus" electric motor may be utilised in the construction of a handy and practical power drill.

These and other features, including the regular columns of Readers' Letters, replies to Queries, and Club News, will be found in next week's issue.

See page 79

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

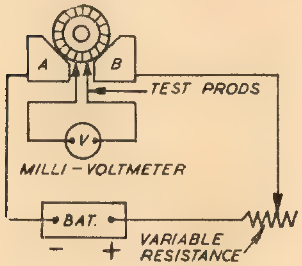
Drop-testing Armatures

Can you please give me information on the drop-testing of d.c. armatures. I have available for testing purposes, a d.c. power supply, from 2 volts to 100 volts and various moving-coil instruments. I wish to be able to test dynamos from the size used for motor-cycle lighting, up to larger machines of 100 to 150 volts.

Is it necessary to apply a varying voltage according to the rated voltage of the machine? Must the milli-voltmeter have a central zero reading? Is the point of contact at "A" and "B" critical?

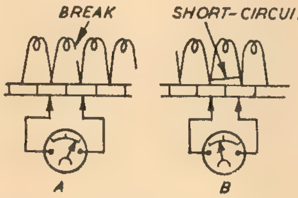
A.M.E. (Heathfield).

Drop-testing is a method of testing armatures to determine certain faults. The test is carried out by the aid of a low-voltage supply, which must be direct current; in addition, a suitable low-reading voltmeter and a regulating resistance is required. The low-voltage supply will be connected to commutator bars at a suitable place; this will be decided by the manner in which the armature is wound. The regu-



lating resistance is connected in series with the low-voltage supply and the armature. An ammeter is useful in this circuit to check the current flowing, so that damage is not done to the windings by excessive heating; also, any progressive heating while the test is being taken can upset the progressive readings obtained on the voltmeter. It does not matter whether the voltmeter is a centre-zero one or not, but it should be a sensitive one. The testing meter is provided with two prods, and the test is carried out in the following manner.

The supply is connected to two commutator bars on the armature.



If the armature is lap wound, the bars will be at 180 deg. apart; if it is wave-wound the bars need to be at 90 deg. In the absence of any suitable clamping device, it is preferable to solder these leads to the bars, because it is important that a sound connection is made. Having switched on the supply current, the voltmeter prods should be contacted to two adjacent bars, and the regulating resistance adjusted until a firm reading is obtained on the meter; now, commencing at the bar on which is a soldered supply lead, put one prod on this bar, and the other prod on the next bar to it. You can call these bars one and two. You will get a reading of some kind. Now move prods to bars two and three, you will now get a reading which should be the same as the reading on bars one and two. Progress round the armature in this manner, so that every coil is checked; when you get past the last bar on the opposite supply lead, the reading will be in the reverse direction; if you have not a centre-zero meter you just change the prods over. In testing in this way, if you get a reading that is higher by some amount than the standard readings, this will indicate a high resistance circuit. If a lower reading is given, it shows that there is a partial short, or a low resistance circuit; if you get no reading at all, this is definitely a shorted coil. During the test, if you get full supply volts across the test meter, this indicates an open circuit in the coil under test. Should you get a reverse reading on two bars, this shows that the coil under test is connected in reverse order to the bars. Suitable test voltages are in the range of 6-20, and if a heavy current armature is being tested, the input current needs to be heavy, otherwise a very sensitive meter will be necessary to obtain a satisfactory reading.

Spray Painting Difficulty

I have been respraying my car recently and after applying five coats of air-drying cellulose, rubbing down with fine wet or dry sandpaper and finishing off with a polishing paste, I have achieved a pretty good finish, marred only by the presence of minute holes which, when viewed under a magnifying glass, appear to be round as if they had been air bubbles.

Could you please tell me their cause? The spray used was only a vacuum cleaner type.

T.J. (Newcastle-on-Tyne, 1).

There are several things which might cause this trouble but the most likely is insufficient spraying pressure.

The pressure obtainable from a vacuum cleaner is extremely small, and, unless used in a specially designed type of spray gun, is often found inadequate for atomising the cellulose properly.

It might be possible to improve matters by thinning the paint down more than is usual.

Milling in Bench Drill

I have a Fobco ½-in. bench drill that I wish to use as a vertical milling machine for light work.

The spindle speeds are too fast for milling, and I must rig up some sort of speed reduction. What spindle speeds do you recommend me to obtain?

E.M.A. (London, S.E.26).

The speeds at which cutters should run will depend very largely on their diameter, and also the class of work in hand.

For small cutters, we are of the opinion that the standard bench drill speeds would not be too high, but generally speaking, for any purpose except small cutters with very light cuts, the bearings of a standard type of bench drill are not suitable for milling.

In the circumstances, we suggest that the correct milling speeds could only be ascertained by experience.

WITH THE CLUBS

Society of Model & Experimental Engineers

Members will be sorry to learn that our conscientious and indefatigable secretary, Mr. E. C. Yalden, is too ill to undertake his duties for some weeks, and members are requested, for the time being, to address their correspondence either to: Mr. A. E. Case, Librarian, 28, Wanless Road, S.E.24, or Mr. G. W. Wildy, 157A, West End Road, Ruislip, Middlesex.

Pending the issue of the society's programme, members should note that on Saturday, July 17th, there will be a rummage sale at the headquarters, 28, Wanless Road, at 2.30 p.m. On Sunday, July 18th, there will be an official visit of the society to the recently opened Beech Hurst track at Haywards Heath, Sussex. This track, which is situated in the beautiful surroundings of the Sussex Downs, is opposite the Cottage Hospital, on the road to Cuckfield. A car park is available, and may be reached from Bolmore Road, opposite the "Sergison Arms." Our hosts, the Sussex Miniature Locomotive Society, will be pleased to see as many members as possible.

Salisbury & District M.E.S.

The society's recent exhibition resulted in a great influx of new members, several of them being small-gauge railway enthusiasts. It is, therefore, proposed to form a Model Railway Section and to build a layout in the society's new headquarters, and all local railway modellers are invited to get in touch with the secretary. The society has gratefully accepted the gift by Mrs. Anderson of Awbridge of a quantity of track and rolling stock, and a length of outdoor track for steam locos is planned.

Hon. Secretary: R. A. Read, 90, Woodside Road, Salisbury.

South London Model Engineering Society

The above society's regatta, arranged to be held on July 18th, at Brockwell Park, has had to be postponed, owing to weeds appearing in the pond.

THE MODEL ENGINEER DIARY

July 18th.—The North London Society of Model Engineers.—Opening of the society's new multi-gauge track at Arkley, Barnet, 3 p.m.

July 25th.—Victoria Model Steamboat Club.—Regatta at Victoria Park, London, E.9.

August 11th, 12th, 13th, 14th.—Exmouth & District Society of Model and Experimental Engineers.—Exhibition at the Y.M.C.A. Hall, Victoria Road, Exmouth. Opening day from 7.30 p.m. to 9-0 p.m.; other days from 10-0 a.m. to 9-0 p.m.

August 16th, 17th, 14th, 19th, 20th, 21st.—Ramsgate & District Model Club.—Exhibition at Club headquarters, Princes Street, off Queen Street, Ramsgate. Open from 3-0 p.m. to 9-0 p.m. daily, except on Saturday, when the opening time will be 10-30 a.m.

August 18th, 19th, 20th, 21st.—Weymouth & District Model Engineering Society.—Model Railways and Engineering Exhibition, at the Melcombe Regis Boys School, Weymouth. Open from 11 a.m. to 9 p.m.

August 18th, 19th, 20th, 21st, 23rd, 24th, 25th, 26th, 27th and 28th. The Model Engineer Exhibition, in the New Horticultural Hall, Greycoat Street, Westminster, S.W.1. Open from 11 a.m. to 9 p.m.

August 23rd to September 4th.—Exeter and District Model Engineers' Society.—Exhibition at the Friernhay Hall, Exeter.

CORRESPONDENCE

The Managing Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Correspondence and manuscripts should not be addressed to individuals, but to the Managing Editor, The Model Engineer, 19-20, Noel Street, London, W.11

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WORKSHOP EQUIPMENT

Buck & Ryan for Lathes and Accessories, drilling machines, grinders, electric tools, surface plates, etc.—310-312, Euston Road, London, N.W.1. Phone : Euston 4661.

"Impetus" machines, wood planers, motorised drills, belt sanders, electric motors, paint sprays, air compressors, circular saws, etc. Catalogue.—John Steel, Castlefields, Bingley.

Rebuilt Lathes. The Acorn Machine Tool Co. (1936) Ltd., offer rebuild to limits "Acorntools" and "Atlas" 10" swing s.s. available. Write—610-614, Chiswick High Road, W.4. (Phone : CHI 3416).

Edwards & Drage (Tools) Ltd., Exeter, offer : Myford Super Seven M.L.7 (metal) and M.L.8 (woodworking) lathes, ex-stock. Immediate delivery, also Brook F.H.P. motors and M. & W. micrometers, etc. Favourable h.p. terms available. Distributors—S.N. Bridges electric tools. Catalogue on request (trade supplied).—Edwards & Drage (Tools) Ltd., 131, Magdalen Road, Exeter. Tel. : 56134.

New (Slightly Soiled) $2\frac{1}{2}$" 3-jaw (reversible) scroll chucks (model 32) Burnerd, reduced from £5 8s. to £3 10s. (1s. 9d. p. and p.). List supplied on request.—John Morris (Clerkenwell) Ltd., 74, Clerkenwell Road, E.C.1.

Special Offer. Several Atlas Model No. V54 bench lathes, 5" height of centres, 36" between centres, fully sliding surfacing and screwcutting back geared machines, 25/32" hollow spindle, 16 spindle speeds complete with change wheels, faceplate, toolpost and chuck and electrical equipment either 3-phase or single-phase, machines have Babbit bearing headstocks, are second-hand, but very little used. Price each £65. Inspection invited. Write phone or call.—The Acorn Machine Tool Co. (1936) Ltd., 610-614, Chiswick High Road, London, W.4. Telephone No. Chiswick 3416 (5 lines).

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The $2\frac{1}{2}$" × 10 E.W. Lathe. Unrivalled in its class. Plain lathe £13 4s. Fully convertible to back gear and screwcutting. Can be obtained on the easiest of terms from 5s. weekly. Send s.a.e. for details. Adept, lathes, shapers, Perfecto shapers, Britinol blow lamps. No interest, no fuss credit terms. Details s.a.e.—Wanstead Supply Co., 48, High Street, London, E.11.

Sale $2\frac{1}{2}$" × 8" Flexispeed Lathe, screwcutting, back geared, countershaft pulley, two vee belts, slides hand scraped by toolroom expert. As new, £25.—Gregory, 20, Wilmot Street, Matlock, Derbys.

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Vertical Slides, "Myford," fixed, £2 ; "E.W." £2 ; "Myford" machine-vice, 12s. 6d. ; all new.—Topping, 219, Byres Road, Glasgow.

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$7\frac{1}{4}$" Gauge Loco, copper boiler, axle feed pump, perfect injector, steam brake, excellent condition and quick steamer. Passenger trucks for ten people, including rails, £275. Any test or examination welcomed.—Box No. 7353, Model Engineer Offices.

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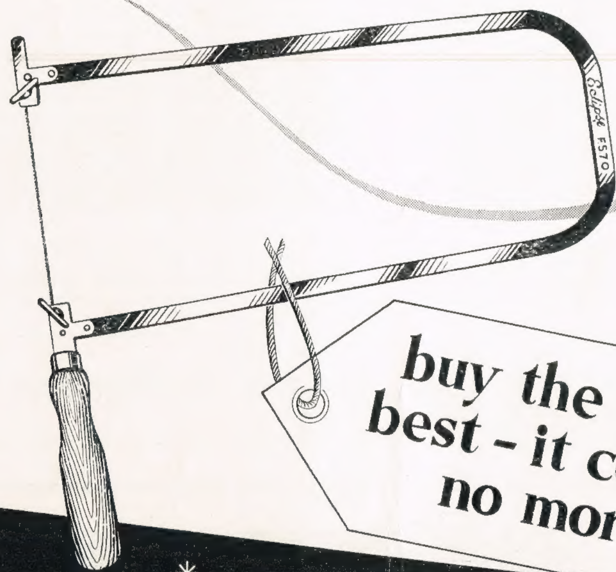

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W 3	5" × ·014" × ·047"			7/6
W 4	5" × ·017" × ·051"	16	1/4" and above	8/-
W 5	5" × ·020" × ·055"			9/-
W 6	5" × ·022" × ·060"			10/-

Ask your dealer for –

Eclipse

FRET SAWS

–frames AND blades

Made by James Neill & Company (Sheffield) Ltd., and obtainable through your usual suppliers

U2/1